October, 1960

The Mining Magazine

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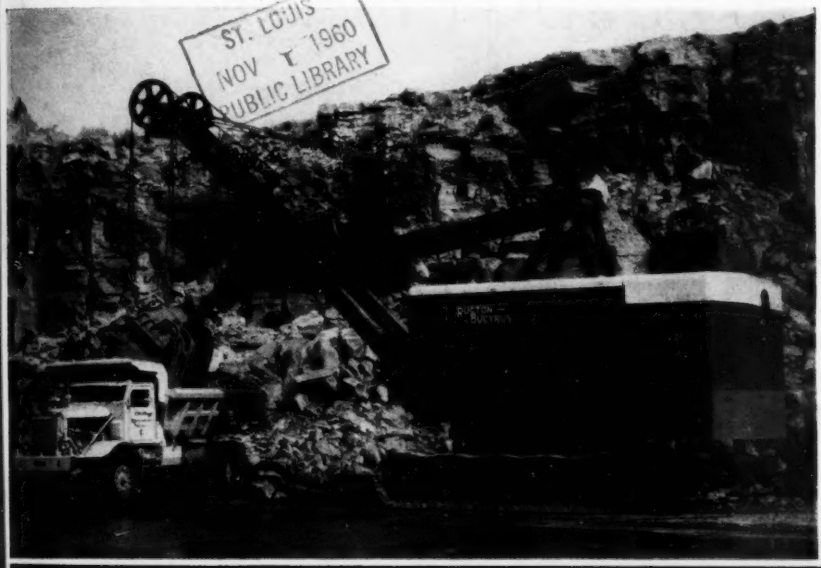

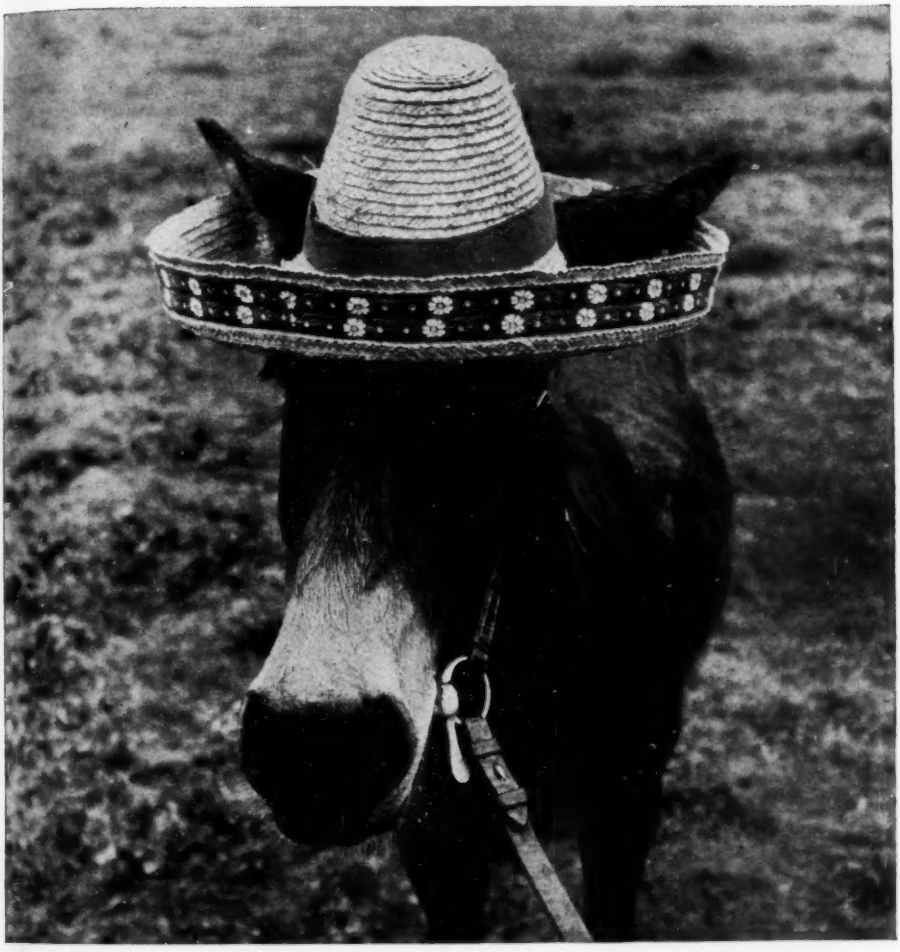

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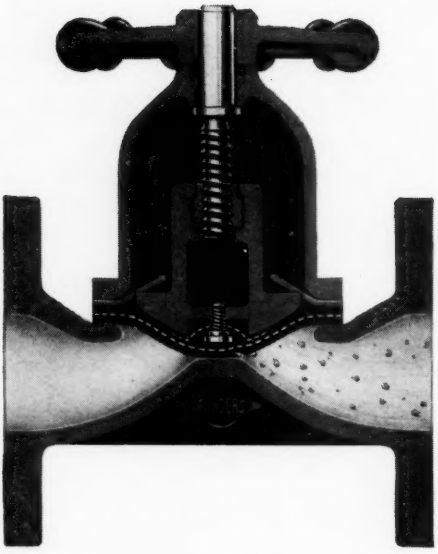

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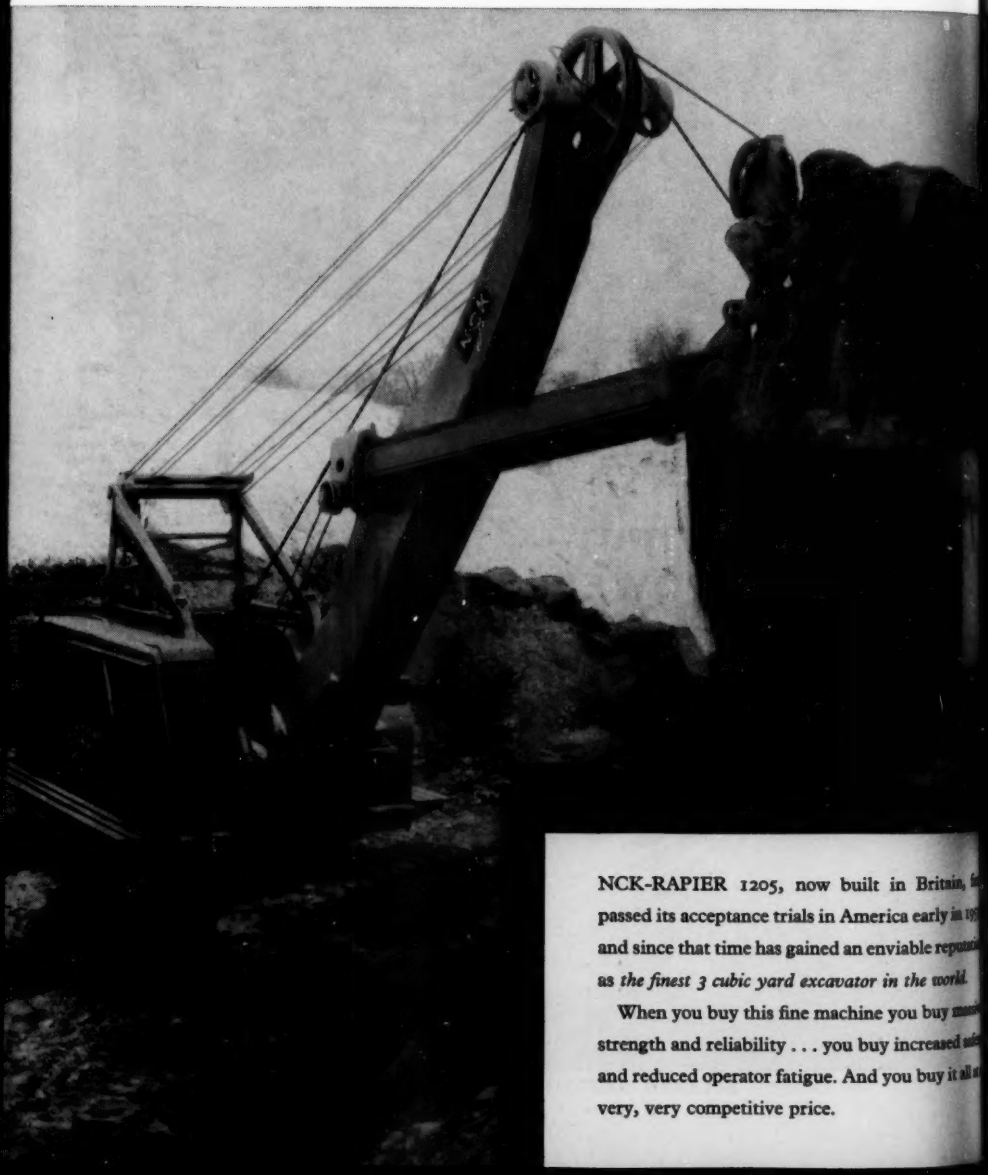

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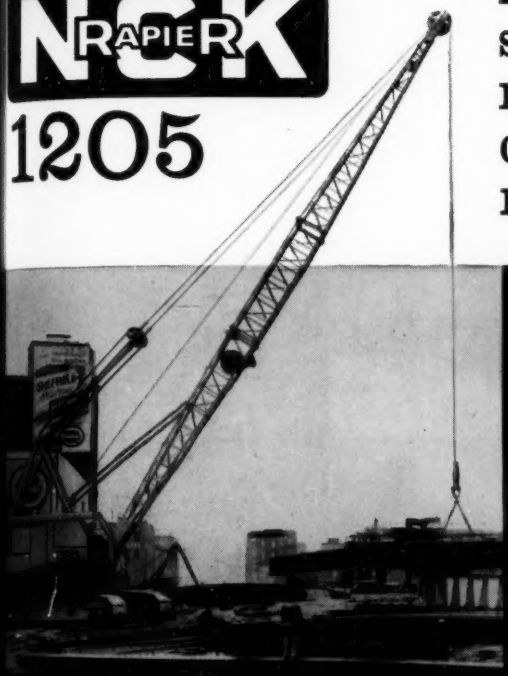

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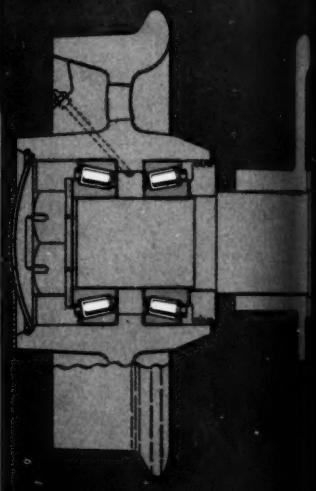

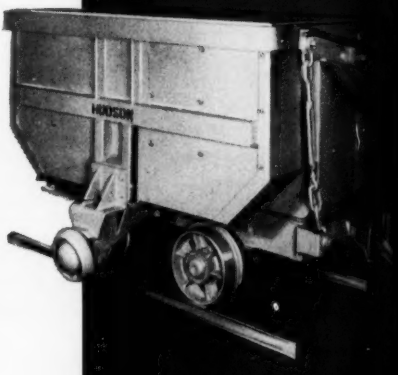

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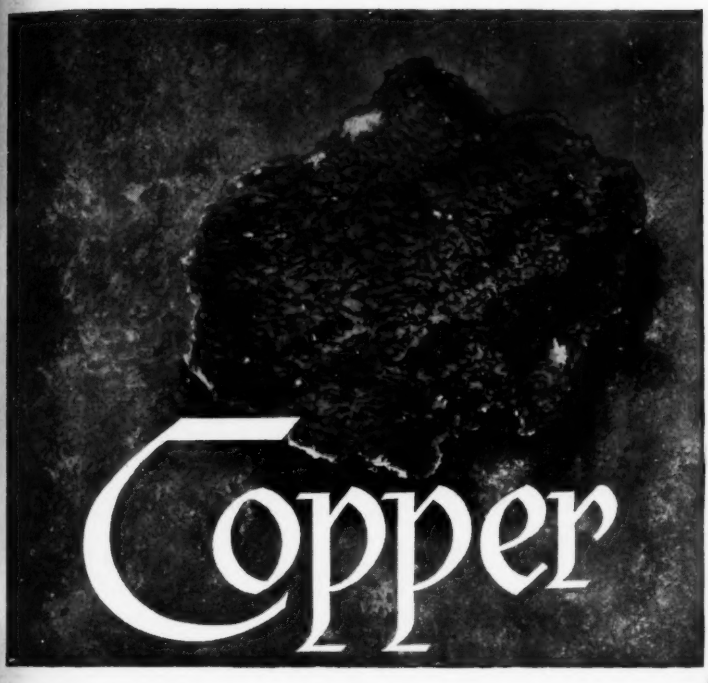

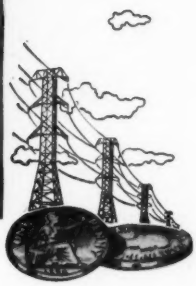

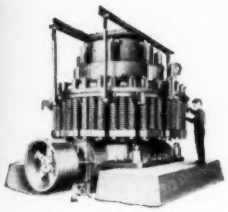

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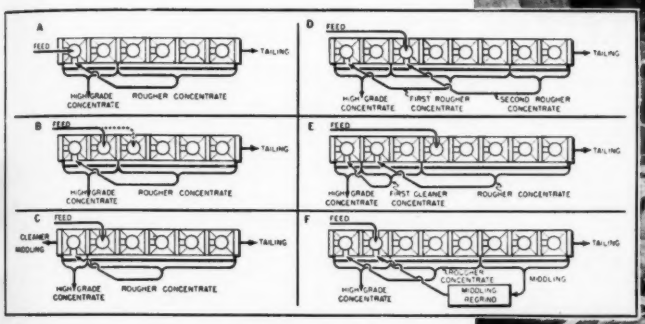

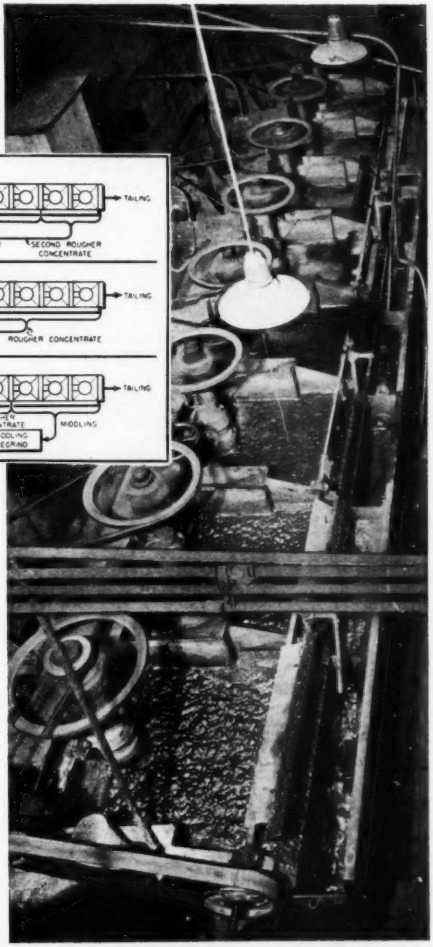

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CONTENTS

EDITORIAL

IT has been announced that a second course of instruction for prospectors and would-be prospectors has been arranged by the Tanganyika Mines Division of the Ministry of Commerce and Industry. To be held at Morogoro in the current month the course will follow the lines of the successful first session held last April.

EACH edition of the " Oil and Petroleum Year Book " [1] seems to gain in stature and the present 1960 issue, which appeared earlier this month, is no exception. The current volume contains complete and up-to-date particulars of 1,100 of the principal oil companies operating in all parts of the world and contrives to cover all branches of the industry. There are, in addition, the usual features and even a new one, covering " Product Demand by End Use, U.S.A. and Europe, 1959." The Buyers' Guide and the section mentioning " Managers, Engineers, and Agents " are, at the same time, as useful as ever.

A NEW sinter plant at Workington Iron and Steel Company, which will cost some £2,500,000, is to be opened early in December by H.R.H. Prince Harald, the Crown Prince of Norway. The existing plant, which has been in operation since 1943, has, it is stated, shown successfully the advantages of using sinter and as additional quantities are now needed the decision was taken to build the new plant. The United Steel Companies state that Norwegian iron ore is particularly suitable for the acid Bessemer process in use at Workington. It is supplied in the form of a concentrate which is finely powdered and therefore demands a sintering technique. The company already use up to 150,000 tons of these concentrates each year and these will be increased to 400,000 tons when the new plant is in operation.

TOWARDS the end of September the Minister of Power, Mr. Richard Wood, inaugurated a supply of natural gas to Whitby, this town on the Yorkshire coast thus becoming the first in Britain to have an all-natural gas supply. Natural gas was originally found in North Yorkshire by the British Petroleum Exploration Co. in 1938 during the course of its search for oil in the U.K. Since the end of the last war this discovery has been further explored jointly with Imperial Chemical Industries, Ltd., with a view to its possible use by the latter, but I.C.I. decided that the reserves of gas were insufficient for their requirements. In September, 1959, the N.E. Gas Board, in agreement with British Petroleum and I.C.I., arranged to purchase the gas as may be made available and, initially, supply Whitby, a town of approximately 12,000 inhabitants. In the course of operation eleven wells have so far been drilled but only two, Nos. 2 and 10, have been proved to be gas producers, the others being dry. The two wells are independent of each other and do not draw from a common reserve.

IN the University of Birmingham the Department of Mining and Minerals Engineering has introduced a new course of three years' duration leading to the Honours Degree of B.Sc. in Minerals Engineering. The course is designed with the view that graduates will have the outlook of the pure scientist and also possess some of the attributes of the engineer and thus apply the principles of science and engineering to the dressing, beneficiation, processing, and utilization of minerals, including non-metallics and coal. The main subjects of the first two years of the course are chemistry, mathematics, geology (particularly mineralogy and petrology), and chemical engineering, together with fundamental aspects of mineral treatment ; other subjects taken in the first or second year include physics and engineering subjects. Chemistry is continued in the final year together with mineral dressing, processing, and utilization, with options which allow a student to spend a certain amount of time in specializing in, for example, processing of minerals or treatment of coal. The course has started with an intake of five students; arrangements for an annual intake of twelve students in the Session beginning in October, 1961, rising to twenty in 1964 have been made. Further particulars of the course

[1] Walter E. Skinner: 20, Copthall Avenue, London, E.C. 2.

may be obtained from the Registrar, The University of Birmingham, Edgbaston, Birmingham, 15.

ACCORDING to a report recently issued by the United States Bureau of Mines [1] an increased trade in minerals by Russia indicates a bolstering of her economic ties with Free-World nations in Africa and Western Europe. Interpreting official Soviet figures on last year's trade in minerals and fuels it is concluded that Russia's mineral exports in 1959 gained 14% in value over 1958 and were twice the 1955 value, while the value of mineral imports last year was less than 7% above the 1958 figure and 40% higher than the total mineral import value five years ago. In the year under review the Soviets cut down on shipments of zinc, tin, and aluminium to Free-World countries in 1959, while delivering substantially more of many bulk products, including solid and liquid fuels, iron ore, pig iron, rolled steel, manganese ore, chromite, asbestos, apatite concentrate, and potash salts. Minerals and fuels accounted for more than a third of the value of all Russian exports in 1959, with liquid fuels and coal showing the biggest gains over the previous year. Although fuel imports also increased the country remained a large net exporter of both coal and petroleum. It is suggested that, reflecting changing economic and political objectives, Russia imported increased quantities of minerals and fuels from such countries as Austria, Belgium, West Germany, France, Yugoslavia, Sweden, Rhodesia, Uganda, and the Union of South Africa. Whereas the United Kingdom supplied 70% of the ingot copper imported by Russia in 1958, over half the 1959 supply came from Rhodesia and Uganda. Although the 1959 copper imports were substantially larger the United Kingdom supplied less than 25% of the total.

Mining Research in South Africa

At the annual meeting of the South African Institute of Mining and Metallurgy held in Johannesburg on August 24 the newly-elected president, Mr. W. S. Findlay, chose as the subject of his address " Research in the South African Gold Mining Industry." By way of introduction he suggested that the two main problems of the industry were first to find a payable orebody and, secondly, to exploit it to the best advantage both of the company concerned and of the country in which it occurred. There is, of course, said Mr. Findlay, a third problem, that of finding enough money to establish a mine, but he proceeded to indicate that his primary concern was to discuss the research into matters affecting the actual exploitation and development of gold mines. The problems which confront the mining engineer in the Union, he went on to say, become more and more complex because of the ever-increasing depths at which the mines are being worked and concrete results could emerge only if basic and applied research could go on together.

Pursuing this idea the president suggested that mining problems requiring applied research had one feature in common—namely, that the circumstances under which the problems occurred were rarely reproducible, so that the only satisfactory laboratory was frequently the mine workings themselves. Basic research, however, found its real home in the university and research establishments, where pure research could be carried out as an end in itself. In South Africa there was no national mining research institute, the initiative for research into the problems of gold mining and the funds to finance it coming very largely from the industry itself. Under the Group system the Transvaal and Orange Free State Chamber of Mines represented the interests of the industry as a whole and research of common interest to members was undertaken by the Chamber. All mine managements, said Mr. Findlay, are continually being faced with problems of greater or lesser degree of magnitude, many peculiar to the individual mine. To this end those in charge had established study departments, but if the mine is unable to help itself in regard to a particular problem it has the immediate advantage of being a member of a group which provides consultative services. There remains, however, a number of vital problems of common interest—such as, pneumoconiosis, problems concerning heat and humidity or control of strata movement, which by common consent are dealt with through the Chamber. This type of research has expanded rapidly in recent years.

The investigation of silicosis was one of the first problems tackled in the new mining

[1] Mineral Trade Notes Supplement No. 60: The Foreign Mineral Trade of the U.S.S.R. in 1959. Pittsburgh: Bureau of Mines.

field, the first formal body established by the Chamber of Mines to deal with the problem—the Standing Committee on Dust Sampling—being established in 1914 with a staff of dust samplers who visited mines. As the work developed and mines became deeper and more extended it was realized that the study of dust in mine air involved the consideration of general questions of ventilation and that such questions were also significant in the study of the physiological problems arising in unaccustomed conditions of temperature and humidity. In 1931 the entire subject, therefore, was placed under a newly-established body, known first as the "Mine Air Committee" and later as the "Ventilation Problems Sub-Committee." The laboratories of those committees were situated in the head office premises of the Chamber of Mines. Another problem was that of fungal decay in mine timber. The idea of prolonging the life of timber by a preservative treatment was first suggested in 1916 and in 1919 experiments were started at various mines, while in 1926 an experimental pressure cylinder for the treatment of timber with preservative solutions was erected. Preliminary research into the actual fungi causing decay in mines was found necessary and this was begun by the Chamber in 1930 in the laboratories of the University of the Witwatersrand. This preliminary research yielded promising results and in 1936 a Timber Research Laboratory was established to continue and expand the work. These new methods of preservation, which had resulted in the life of the treated timber being increased from two-and-a-half to three times, and certain materials such as filter cloths which were formerly liable to perish after 25 shifts now lasted for as long as 325 shifts. A signal success resulting from this study of fungi was the control of the outbreak in the mines in 1942 of an epidemic of sporotrichosis, a disease caused by a fungus found in mine timber. The Timber Research Laboratory quickly found effective means of combating the growth of the fungus and a possible disaster was averted. The construction of the present Chamber of Mines Research Laboratory was started in 1949 and the building was officially opened in 1951. It now houses the Biological and Chemical Research Laboratory—the former Timber Research Laboratory more appropriately renamed—and the Dust and Ventilation Laboratory. The cost of these laboratories, together with ground and equipment, was about £250,000. However, the president said, one of the mining groups, in conjunction with the Council for Scientific and Industrial Research, began in 1950 the investigation of human physiological problems arising from work in mines and the Chamber of Mines decided to erect a laboratory for the study on an industry basis of problems in applied physiology. The erection of the laboratory at Crown Mines was begun in 1954 and the major experimental unit of the laboratory, the climatic chamber, was commissioned in June, 1956. The laboratory is known as the Applied Physiology Laboratory and cost about £200,000 to establish.

Nowadays, control of the Chamber's research activities is vested in a Research Advisory Committee, which operates under the direction of a Technical Advisory Committee, a body of consulting mining engineers to the industry, and ultimately to the Gold Producers' Committee, which votes the amount of money required. A series of project and laboratory steering committees is instituted by the Committee and a project once approved in principle is referred to the steering committee concerned for a report on the proposed programme and an estimate of the cost involved. The work is then undertaken by the laboratory concerned and reports and recommendations flow from the Director of the Laboratory through the steering committee to the Research Advisory Committee and thence to the Technical Advisory Committee and the Gold Producers' Committee. If approved, they are circulated to those mines which are members of the Chamber. On occasion, of course, the Chamber's laboratories are not suitably equipped, the president said, to carry out particular work or it is thought appropriate for it to be carried out by some other organization. In all cases, however, the orginization employed is the most knowledgeable, the best equipped and, consequently, said Mr. Findlay, the best suited to carry out the work required. Finally, if work has to be done under operating mining conditions assistance is obtained from individual mines and groups, either with or without the aid of one of the outside bodies referred to, the project being carried out on behalf of the industry as a whole. All in all, it is felt, the research activities of the South African gold-mining industry should "increase still further its stature as a leader in the field of mining technology." Research, in any case, plays no small part in such an ambition.

MONTHLY REVIEW

Introduction.—Arising out of the "credit squeeze" now taking its effect on industry there is a general lessening of business confidence. Except for constructional materials there is a worsening demand for base metals and copper producers in Africa and Canada have announced a 10% cut in metal marketed. At the same time the South African mining industry continues to break records, the gold output for the September quarter reaching 5,441,621 oz.

Transvaal.—The output of the Rand mines for August totalled 1,778,711 oz. and that of outside mines 36,777 oz., making a total of 1,815,488 oz. for the month. Corresponding figures for September are 1,774,967 oz. and 35,352 oz., a total of 1,810,319 oz. At the end of September there were 369,751 natives at work in the gold mines, as compared with 374,303 at August 31.

More reef intersections in the course of shaft sinking have been announced by several companies during the past month. In the WESTERN AREAS GOLD MINING COMPANY'S property, for example, the Ventersdorp Contact Reef was cut in the main shaft at 3,323 ft. below collar. This was followed by numerous mineralized conglomerate bands of the Elsburg Series intersected between 3,326 ft. and 3,430 ft., all the reefs dipping in a southerly direction. As in the ventilation shaft, it is stated, the dips of the Contact Reef and the Elsburg Series indicate that they are not conformable and largely as a result of this fact certain bands of the Elsburg Series were not exposed over the full perimeter of the shaft. A station was cut at 3,360 ft. and developments incidental to the station layout passed through certain horizons of the Elsburg Series all of which, as far as can be determined, had been intersected in the shaft. Some good values are reported.

At DOORNFONTEIN GOLD MINING the Carbon Leader has been intersected in No. 1A Sub-Vertical Shaft at 1,846 ft. below collar. The exposure was complete and sampling of 15 sections around the periphery of the shaft averaged 8·5 dwt. per ton over a reef channel width of 8·6 in., equivalent to 73 in.-dwt. Then at BRACKEN MINES the No. 1A Shaft intersected the reef at 2,336 ft. below collar, sampling around the whole perimeter giving 23·30 dwt. over 37 in., equivalent to 863 in.-dwt.

The accounts of LUIPAARDS VLEI GOLD MINING for the year ended June 30 last show a profit of £1,131,913 and a total of £1,316,974 available, of which dividends equal to 2s. a share require £496,911. In the year 832,000 tons of ore from the Main Reef section was milled for 145,974 oz. of gold, while 618,000 tons of Bird Reef ore yielded 18,674 oz. of gold and 787,980 lb. of uranium oxide. Ore reserves on the Main Reef are given as 1,363,000 tons averaging 4·5 dwt. in value and those on the Bird Reef as 1,107,000 tons averaging 1·3 dwt. in gold and 1·86 lb. of uranium oxide per ton. The report states that progress was made in prospecting the faulted ground between No. 1 and the Witpoortje Fault. Crosscuts from existing Bird Reef development intersected No. 1 Fault on 27 and 29 Levels and three bore-holes were drilled from the surface to the Bird Reef horizon, two of which failed to intersect the Monarch Reef owing to disturbed ground. The third cut the Reef at 1,140 ft. assaying 128 in.-lb. over a corrected width of 14 in. Further work is necessary, it is thought, before it will be possible to determine whether sufficient ore exists between faults to warrant exploitation.

The operations of DOMINION REEFS (KLERKSDORP) in the year to June 30 last resulted in a profit of £1,006,801. Dividends totalling 3s. a share were declared, requiring £296,288. In the year 494,700 tons of ore treated for uranium oxide yielded 528,060 lb. while 213,440 tons milled for gold produced 2·722 oz. At June 30 the ore reserves were estimated to be 427,000 tons averaging 1·75 lb. of oxide per ton.

With the recent dividend notice shareholders of RUSTENBURG PLATINUM MINES were informed that the profit for the year to August 31 amounts to £2,423,000. It is stated that at the mine the scale of operations was increased during the year for the purpose of building up stocks of metals. In order to achieve maximum metallurgical and overall efficiency operations were also adjusted between the various mining sections and reduction plants available and these adjustments involved the commissioning during the year of the new reduction plant completed in 1957 at the Rustenburg Section. Further adjustments in the scale of production as between the various mining sections are to

be made from time to time in the light of prevailing circumstances.

At Umbogintwini on the Natal south coast a £3,000,000 titanium oxide plant is under construction. It is being built by SOUTH AFRICAN TITAN PRODUCTS (PTY.), LTD., a company formed by BRITISH TITAN PRODUCTS and CHEMICAL INDUSTRIES, LTD. It is expected to be completed by 1962 and will have an initial capacity of 10,000 tons per annum.

ZAAIPLAATS TIN MINING announces that the estimated profit from all sources for September was £7,120 before providing for taxation and expenditure on special development. The western exploratory drive has exposed a new ore body carrying rich values at the point of intersection. This body is 900 ft. from the nearest other working in which ore was mined and 600 ft. vertically below surface. It will be some time, it is stated, before the full importance of this discovery can be accurately assessed.

At the end of September the directors of RAND SELECTION CORPORATION, LTD., announced that the £1,000,000 4½% ten-year unsecured loan stock, 1960, which was placed privately in the United Kingdom in 1950 has been redeemed.

The accounts of LYDENBURG ESTATES for the year ended June 30 show a profit of £32,224 and £110,100 available. A dividend equal to 1s. 3d. a stock unit requires £26,631, while £70,000 has been transferred to reserve, leaving £13,469 to be carried forward.

Orange Free State.—In a recent circular shareholders of FREDDIES CONSOLIDATED MINES have been informed that work on development required to test the Elsburg Reefs in an area adjacent to the western boundary of the Mining Lease Area is being continued. It is still expected that by the end of 1960 it should be possible to obtain by underground diamond drilling some information regarding the Elsburg Reefs. In order to reduce expenditure before a final decision can be reached regarding the Elsburg Reefs, development in other parts of the mine has been reduced to a level which is likely to result in a progressive reduction in ore reserves. Present indications are that mining operations, including such development as may be necessary for a preliminary exploration of the Elsburg zone, together with a limited amount of development on the Basal Reef horizon can be continued during the remainder of 1960 and the first half of the year 1961 and that small profits will be reflected which should be sufficient to protect the cash resources of the company during that period.

Diamonds. — DE BEERS CONSOLIDATED MINES has announced that diamond sales through the Central Selling Organization totalled £22,566,309 in the September quarter, gem stones accounting for £15,751,801 of the amount. Total sales for the first nine months of the current year now total £66,295,023. De Beers has also announced that it has arranged for the production in South Africa of synthetic diamond grit on a commercial scale. At the present time there are ample stocks of natural diamond grit for the world market, but in view of the interruption of diamond mining operations in the Congo the production of synthetic material is being undertaken as a precaution to ensure that there will be no break in supplies to the market.

Northern Rhodesia.—With the declaration of a maiden dividend the directors of BANCROFT MINES report an operating profit of £3,693,003 for the year to June 30 last. Shareholders are reminded that when short-term finance was replaced by the issue of £7,500,000 preference shares the capital scheme included the granting of options to subscribe for 3,000,000 ordinary shares at 20s. per share. Good progress has been achieved, it is stated, in opening up the ore-body and satisfactory profits have been earned during the past year, but the company is confronted with a heavy programme of capital expenditure over the next few years for the further development of the mine and the expansion of productive capacity. Thus it has been necessary to ensure that further capital funds towards the financing of this programme would be available. Accordingly it has been agreed that in consideration of option holders undertaking to exercise the options when requested to do so the price at which the shares shall be subscribed will be reduced to 17s. 6d. per share.

In declaring final dividends for the year to June 30 last ROAN ANTELOPE COPPER MINES reports a profit of £4,112,413 and MUFULIRA COPPER MINES one of £5,654,107. CHIBULUMA MINES made a profit of £1,734,074 for the same year, while RHODESIAN SELECTION TRUST made a profit of £2,432,499.

The RHOKANA CORPORATION reports an operating profit of £7,311,928 for the year ended June 30 last and RHODESIAN ANGLO AMERICAN a group net profit of £22,526,460.

Ghana.—The accounts of the KWAHU MINING CO. (1925) for the year ended June 30 last show a profit of £43,267 and £52,697 available. A dividend equal to 30% requires £20,379 of this amount and after other allowances a balance of £12,150 is carried forward.

Nigeria.—Oil production in Nigeria continues to grow, the output for August being 537,197 barrels. Exports for the month totalled 78,978 tons.

Australia.—Last month the CONSOLIDATED ZINC CORPORATION and the BRITISH ALUMINIUM COMPANY announced that by mutual agreement their joint association in COMMONWEALTH ALUMINIUM CORPORATION, PTY., was to be terminated. Since the joint venture had been formed, it was stated, the investigation of possible power resources both in Australia and Papua had been extensively widened. A review of the potential scope of the whole project and the probable magnitude of future operations had led Consolidated Zinc and British Aluminium to the conclusion that the interests of all concerned in the early achievement of further aluminium production in Australia would be best served by the present joint association in Comalco being discontinued, so as to allow for the free and independent development as circumstances may justify of the individual assets respectively contributed to the joint venture. The consent of the Australian Government had been obtained to the transfer of the Gove bauxite lease from Comalco to British Aluminium and the Government had agreed that British Aluminium would stand in the place of Comalco in the negotiations taking place in New Guinea for rights in relation to the Purari River system.

Following the announcement of the termination of the joint association Consolidated Zinc stated that its objectives for the establishment of alumina and aluminium production in Australia and New Zealand remain unchanged. The planning of large-scale alumina production at Weipa in North Queensland was well advanced and the investigations continued on the establishment of a smelter in Queensland based on power from the development of Queensland coal resources. At the same time technical studies were being completed of the hydro-electric power potential of the Manapouri-Te Anau Lakes system in Southland, New Zealand, as a base for the establishment of a smelter in that country for supply to the international market.

The CONSOLIDATED ZINC CORPORATION has announced that, with the consent of H.M. Treasury, the central management and control of its wholly-owned subsidiary the ZINC CORPORATION, LTD., has been transferred to Australia.

It is reported from Western Australia that Japan is keenly interested in mineral developments there. Two copper areas are under survey, one at Whim Creek in the northwest, and one in the extreme south—at Ravensthorpe. Both were well-known in copper-production circles 40 or more years ago. Japan has also shown an interest in the "chat" product from Collie coal and in iron-ore production. Gypsum from Lake Dundas (Norseman) is under inspection and in the recent years she has purchased large quantities of manganese ore (shipped at Port Hedland).

With the recent dividend notice shareholders of MOUNT ISA MINES were informed that the consolidated profit for the year ended June 30 last is £A5,358,239, after providing £A1,355,361 for income tax, £A1,336,161 for provision for income tax equalization, and £A1,550,733 for depreciation. The directors have appropriated £A2,000,000 for capital expenditure and development.

New Zealand.—In the year to March 31 last CLUTHA RIVER GOLD DREDGING recovered 6,133 oz. of gold. Operations resulted in a working profit of £8,860.

Colombia.—In the June quarter PATO CONSOLIDATED GOLD DREDGING treated 5,073,000 cu. yd. of ground and recovered 14,193 oz. of gold. In the period, it is stated, difficult digging conditions were experienced by a number of the dredges and all entered areas of low grade. There was no production for the ten-day period May 6 to 16 because of a shut-down due to a strike.

Dominican Republic.—The ALCOA-operated bauxite deposits at Pedernales earned the country $1,730,000 in exports in the first six months of 1960. Production figures for this period are given as 396,133,000 kg., of which 218,437,000 kg. were sold within the six months.

Peru.—The CERRO DE PASCO CORPORATION is to spend $6,825,000 on plant additions. The new projects involve modification of two production facilities. The electrolytic zinc plant, located at La Oroya, Peru, metallurgical centre in Peru of Cerro's principal operating subsidiary, is to be increased in capacity from approximately 32,000 to 52,000 short tons of special high-grade zinc

a year. In addition the concentrator at Cerro de Pasco, the location of Cerro's principal operating mine, situated at about 14,400 ft. above sea-level in Central Peru, is to be expanded to accommodate increased volume of copper ore and lead-zinc ore to be mined by open-pit methods at this property.

United States.—CAMP BIRD MINING announces the commencement of production at their mining properties in Colorado, the newly-built 500-ton a day ore mill coming into operation on October 10. Following a detailed investigation the work of development and equipment of the mines began four years ago and has been continued by Camp Bird Mining's 100% subsidiary, CAMP BIRD COLORADO, INC., in which ownership of the properties now rests. This has culminated in the design and construction during the current year of the new mill. The work has cost (including the mill) some £900,000. Ore reserves were reported a year ago as 777,000 tons, averaging 0·0325 oz. of gold and 4·38 oz. of silver per ton, with 4·96% lead, 0·535% copper, and 4·34% zinc over a width of 73·9 in., representing a net smelter return of $14·97 per ton of ore. Since then reserves have increased with comparable values and now exceed six years' supply to the mill. Operating costs have been estimated at not over $10 per ton of ore.

Canada.—The RIO TINTO MINING CO. OF CANADA has announced that the Stanleigh uranium mine is to continue to operate until November 30, 1960. When it ceases operations the balance of its contract will be filled from Rio Tinto's remaining uranium producers—Milliken, Nordic, Panel, and Quirke.

Consolidated Gold Fields of South Africa.—The Consolidated Gold Fields of South Africa, Ltd., has announced that it is acquiring for a cash consideration which does not exceed £250,000 an interest of just over 50% in the equity capital of MINING AND METALLURGICAL AGENCY, LTD., which acts as European selling and purchasing agents and general representatives for a number of important overseas mining companies.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated.)

***African and European Investment Co.**—2s., payable Nov. 10.
***Anglo American Corporation of South Africa.**—4s., payable Nov. 10.
Apex Mines.—Pref. 6·6d., payable Nov. 1.
†Bancroft Mines.—1s. 7·2d., payable Dec. 8.
†Blinkpoort Gold Syndicate.—2s. 7½d., payable Nov. 3.
Broken Hill Proprietary.—Half-yearly, 11d. (Aust.), payable Nov. 30.
†Broken Hill South.—5d. (Aust.), payable Dec. 2.
***Cape Asbestos.**—5%, payable Nov. 15.
†Chenderiang Tin Dredging.—6d., payable Nov. 28.
†Clutha River Gold Dredging.—1d., payable Oct. 29.
***De Beers Consolidated Mines.**—Def. 5s., payable Nov. 1.
***Great Boulder Gold Mines.**—6d. (Aust.), payable Nov. 30.
†Harmony Gold Mining Co.—1s. 4½d., payable Nov. 3.
†Kwahu Mining Co. (1925).—30%, payable Oct. 31.
***London and Rhodesian Mining and Land Co.**—4%, payable Nov. 18.
†Lydenburg Estates.—1s. 3d., payable Oct. 25.
†Lydenburg Platinum.—11½d., payable Nov. 7.
***Malayan Tin Dredging.**—7½d., payable Nov. 29.
†Mount Isa Mines.—9d. (Aust.), payable Dec. 30.
†Mufulira Copper Mines.—5s. 3d., payable Nov. 19.
†Ndola Copper Refineries.—5·8%, payable Dec. 17.
†Potgeitersrust Platinums.—1s., payable Nov. 7.
***Pusing Rubber and Tin.**—7·2d., payable Oct. 15.
†Rhodesia Copper Refineries.—3s. 2·4d.
†Rhodesian Anglo American.—9s. 7·2d., payable Dec. 8.
†Rhodesian Selection Trust.—1s., payable Nov. 19.
†Rhokana Corporation.—8s. 9·6d., payable Dec. 8.
†Roan Antelope Copper Mines.—10½d., payable Dec. 17.
†Rustenburg Platinum Mines.—34s. 9d., payable Oct. 12.
†St. Helena Gold Mines.—2s. 9d., payable Nov. 3.
†Southern Kinta Consolidated.—62½%.
***Southern Malayan Tin Dredging.**—7½d., payable Nov. 25.
†Tanganyika Concessions.—2s. 3d.
†Tehidy Minerals.—12½%.
†Union Platinum Mining Co.—1s. 7½d., payable Nov. 7.
†Waterval (Rustenburg) Platinum Mining Co.—1s. 8¾d., payable Nov. 7.
***Winkelhaak Mines.**—4d., payable Nov. 3.

METAL PRICES

Oct. 10.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	200	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	30	5	0
Silver		6	7½
Gold	12	10	8½
Wolfram (U.K.)			
(World)	7	10	0

Tin, Copper, Lead, Zinc } See Table, p. 240.

Oxygen in Steelmaking

W. H. Dennis, B.Sc., M.I.M.M.

The author reviews progress of a development in steelmaking which is increasing production.

Introduction

The constant excess of demand for steel over supply since the war has of necessity stimulated operational research into new methods of increasing production. One of the most important developments in the post-war years resulting from this work is the introduction of oxygen to steelmaking processes. The gas is now being used in all the three main methods of steel making—namely, the Bessemer process, the open hearth, and electric-arc furnace. In addition the advent of " tonnage " oxygen has provided the means of developing new and improved steelmaking techniques, such as the L. D., Kaldo, and Rotor processes.

The manufacture of steel consists essentially in the oxidation of the impurities present in pig-iron by air and iron oxide, the resultant oxides either forming a slag which separates from the metal or escaping in the form of gases. While this method possesses the advantage that the oxidizing reagents are readily available at low cost, it has for long been recognized that the replacement of air by oxygen could effect substantial improvements in the process. The high cost of oxygen has hitherto stood in the way, but in recent years the advent of " tonnage " oxygen at a price and in quantity has made it a practical alternative as an oxidizing agent in steel production. Until recently oxygen was only available in cylinders at a cost of about 12s. 6d. per cu. ft., but large-scale production of gaseous oxygen has enabled the price to be reduced to 2s. or less per cu. ft. As a consequence all the chief steelmaking communities are now installing oxygen plants, ranging in capacity from 100 tons to 500 tons per day.

Bessemer Steel

Basic Bessemer steel suffers from the limitation that due to absorption of nitrogen from the air blast during blowing of the steel it contains about four times (0·012%) as much dissolved nitrogen as open-hearth steel. The higher nitrogen content makes such steels liable to embrittlement and hardening, rendering them unfit for shaping operations which involve severe cold forming such as deep drawing. It is apparent that this

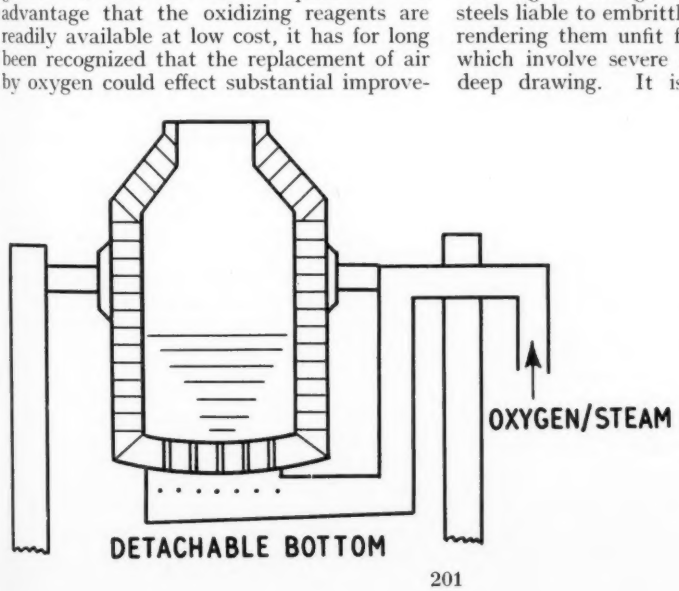


Fig. 1.— Bottom-Blown Oxygen Converter

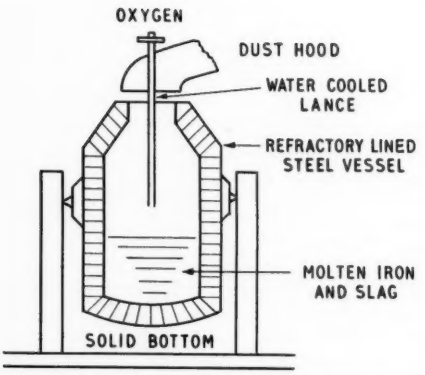


Fig. 2.—LD Top-Blown Converter.

difficulty could be eliminated if the metal were blown with a nitrogen-free gas such as oxygen or oxygen diluted with steam or carbon dioxide to counteract the otherwise severe refractory wear on the converter lining and bottom.

The technique, which was developed on the Continent, has proved highly successful and is being increasingly used for bottom-blown convertors, the steels made in this manner containing nitrogen quantities comparable in quality with the open-hearth product. The quantities of oxygen required for this purpose are of the order of 1,500–2,000 cu. ft. per ton of steel (25,000 cu. ft. = 1 ton of oxygen). A further advantage is that the traditional basic Bessemer process owing to thermal requirements is compelled to operate with a minimum of 1·8% phosphorus in the pig-iron, whereas iron with 1·2% phosphorus can be satisfactorily blown with oxygen. This considerably widens the range of suitable irons, making acceptable a much greater variety of ores.

The trend towards bottom blowing with oxygen has been especially notable on the Continent, where the basic Bessemer process occupies a much more prominent position than in Britain or the United States. The advantages of the process are, however, such that several large British steelmakers have adopted the method.

L.D. Process

The Linz-Dusenverfahren or L.D. process was developed in Austria and arose from the need for a method capable of dealing with an ore too low in phosphorus to operate the basic Bessemer process. While suitable for open-hearth operation the absence of any large quantity of scrap rendered this uneconomic.

The process is carried out in a converter-type vessel (Fig. 2), but in this case the air blast of the normal converter is replaced by a jet of oxygen blown at high pressure on the surface of the molten iron. The vessel is charged with scrap and molten pig-iron and moved to the vertical position. The oxygen lance is inserted to a height of about 3 ft. above the metal, ignition taking place with the production of a brilliant flame which continues until the carbon content of the steel drops to about 0·05%. The converter is then tilted and the slag poured off, followed by the steel. The blowing time is approximately 20 min. with an oxygen consumption of 2,500 to 3,000 cu. ft. per ton of iron. A 50-ton capacity vessel produces 23 heats per day, equivalent to a daily output of approximately 1,000 tons of steel.

The process combines the advantages of low capital expenditure and high speed of working (operating rates of 100 tons per hour have been reported), giving a steel with a very low nitrogen content. In addition it can handle more scrap (15% to 30% as compared to about 5% in the Bessemer process) and loss of time in changing bottoms is eliminated. Little information is at present available as to the effect on the life of the refractories.

LD–AC Process.—The high temperature engendered in the operation described produces a very fluid slag which encourages rapid carbon removal but without appreciable dephosphorization, limiting the method to pig-iron with less than 0·4% phosphorus. For elimination of this element a highly basic slag is necessary, which can be achieved by the injection of finely-ground lime. Slag in the form of foam is necessary, however, and this is produced by addition of bauxite and iron ore. Unless the slag foams phosphorus removal is not effective.

The vessel is charged with pig-iron, scrap, and lime, the oxygen lance being lowered to a distance of about 5 ft. above the molten metal and blown for five minutes at a rate of about 2,000 cu. ft. per min. After 5 min. the lime injection system (which is coupled to the oxygen lance) is turned on at the rate of about 300 lb. per min. After a further 20 min. the reaction is complete, the slag and metal being poured in the ordinary manner. Owing to the intimate contact of the metal with the highly basic slag the degree of desulphurization is of a high order.

Table 1.[1]

Zaporozhstal Open-Hearth Performance Data.

Oxygen content of air, %.	*Oxygen consumption, cu. ft./hour.*	*Heat time (hours), tap/tap.*	*Production rate, tons/hour.*	*% reduction in fuel consumption.*
21	—	8·5	21·9	—
24·8	1,362	7·3	26·1	14·7
25·2	1,398	6·36	28·8	19·3
30	2,450	5·3	34·5	29·3

[1] *Iron and Steel*, Dec., 1959.

The use of the L.D. process is being rapidly extended and to-day 47 plants are in operation or are under construction with a capacity of 20,000,000 tons.

Rotary Converters

A radical departure from the top-blown procedure is the injection of oxygen while the bath is rotated with the object of ensuring rapid slag-metal reaction. Two different types of rotary converter have been developed, one in Sweden, known as the Kaldo, and the other a type originally designed for pretreatment of iron for open-hearth furnaces. This was pioneered at Oberhausen, in Germany, and is known as the Rotor.

Both these processes represent an attempt to obtain high metallurgical efficiency combined with thermal economy.

The Kaldo apparatus (Fig. 3) comprises a cylindrical refractory-lined vessel rotating on an inclined axis at speeds of up to 30 r.p.m., an oxygen jet being blown on to the surface of the metal. Consumption is normally about 2,500 cu. ft. per ton of pig-iron. Variations in the rate of oxygen supply and the speed of rotation enable a close control of steel composition. The method is capable of dealing with iron containing up to 2% phosphorus and produces low-nitrogen steels comparable in grade with open-hearth metal. The carbon monoxide formed by oxidation of carbon in the iron is burnt to carbon dioxide within the furnace, the significance of this being that the formation of carbon dioxide from the monoxide releases approximately the same amount of heat as that due to the oxidation of the impurities contained in the pig iron, the additional heat thus released being available for the melting down of relatively large quantities of steel scrap.

The Rotor (Fig. 4.) is a cylindrical kiln rotating in a horizontal plane at a speed of 0·5 r.p.m., oxygen being injected through water-cooled nozzles both below and above the bath surfaces and independently controlled. The former performs the oxidation, the latter serving for conversion of the monoxide with resultant high thermal efficiency. Using a double slagging technique it is possible to treat high-phosphorus irons and thus obtain substantial credit for the slag sold as phosphatic fertilizer. Units of 100 tons capacity with an annual output of 500,000 tons are in use.

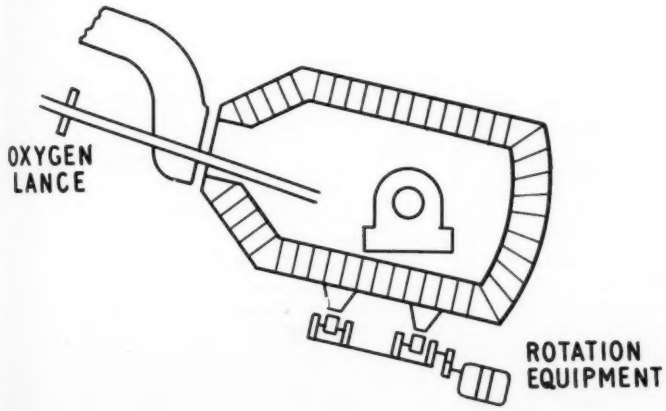


Fig. 3.—Kaldo Rotary Converter.

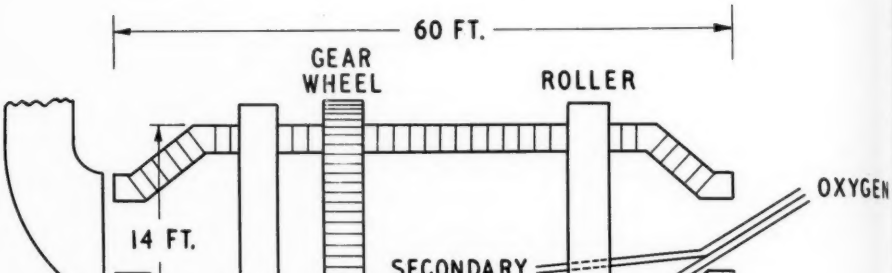


Fig. 4.—Oberhausen 100-ton Capacity Rotor Converter.

Open-Hearth Furnace

The open-hearth steel furnace is flexible in operation, being capable of treating varying quantities of steel scrap and pig-iron both solid and molten, irrespective of phosphorus and sulphur content. It, however, suffers from many defects, prominent among which are high fuel consumption and slow rate of operation. By the use of oxygen it has now been established that substantial improvements in the melting rate and reduction in fuel consumption can be made possible, as the results shown in Table 1, obtained in a Russian steelmaking plant, clearly show. Acceleration of the melting rate can be achieved by enrichment of the flame—*i.e.*, replacement of part of the air by oxygen—the intensity of combustion being greatly increased and permitting higher thermal input.

Another method of increasing production is to reduce the metallurgical load by the introduction of an intermediate step performed outside the furnace for getting rid of sulphur, silicon, and phosphorus by their removal as slag prior to open-hearth treatment. This pre-refining step consists in the injection of oxygen and addition of lime to the liquid metal contained in a ladle, the metalloids being removed in a receptive slag formed by the lime leaving the carbon to be eliminated in the furnace. An average of about 300 cu. ft. of oxygen per ton of iron is required. The application of this method leads to a reduction in the work normally carried out in the furnace and consequently to a substantial improvement in the rate of production.

One of the latest developments is to apply the same principle as used in the L.D. converter, a jet of oxygen under pressure being directed *via* a water-cooled nozzle on to the surface of the molten metal. The momentum of the gas stream enables it to penetrate the slag layer, the impurities in the underlying metal being rapidly oxidized. During this period no external fuel is used, the normal supply of gas or oil being turned off.

These methods result in an increase of about 50% in production and reduction of about 30% in fuel consumption. Consumption of refractories, however, increases about 20%. Even so the saving in fuel and time more than counterbalances the increased cost of refractories, the nett reduction in costs when using oxygen at the rate of about 1,000 cu. ft. per ton amounting to about 4%. On an average every 1·4 tons of oxygen injected to the bath results in a reduction of 20 min. of the operational period.

Electric Furnace

The use of oxygen in the arc furnace has for long been established for the rapid removal of carbon in the refining of alloy and special steels. Compared with the old method of carbon removal with iron ore the rate of oxidation is three or four times as rapid. In addition the reaction is exothermic and thus during the period of oxygen injection the

power supply may be curtailed or even cut off, leading to a reduction in operating costs. Furthermore, in the manufacture of chromium stainless steels, a very low carbon content is frequently required which is difficult of attainment by ore refining, as at the normal temperature of operation chromium tends to oxidize before the carbon. The use of oxygen, however, enables a temperature of 1,800° C. to be reached, at which carbon can be rapidly oxidized without appreciable loss of chromium.

Formerly the arc furnace has been regarded as mainly suitable for the production of special steels and this has tended to limit its size. However, one of the modern features of electric steelmaking is the introduction of large furnaces up to 200 tons capacity which produce plain carbon steels in competition with the open-hearth. The capital cost compares favourably with the open-hearth and yield of metal is somewhat better. The differential between the cost of electric power and oil or gas is becoming more favourable in view of increased thermal efficiency—65% as compared with open-hearth practice in which only about 25% of the total heat available is usefully employed.

As economic operation of these large arc furnaces depends largely on accelerated working the use of oxygen to effect rapid removal of carbon is essential, a high flow being necessary to produce the required carbon drop, amounts of the order of 1,200 cu. ft. per hour per ton being employed.

Conclusion

During the last ten years the use of oxygen has become well established for electric furnace refining and in the manufacture of low-carbon steels in the open-hearth, enabling increased tonnages of steel to be produced at lower cost than formerly. The L.D. process is being rapidly developed in many countries and there are many basic converters producing high-quality steel by the use of oxygen. Rotary converters using any type of pig-iron produce best-quality steel at low cost. It may thus be stated that oxygen is used to-day in so many steelmaking processes that the gas can be regarded as one of the basic raw materials.

The Diamond Deposits of Yakutia

N. W. Wilson, A.R.S.M., A.I.M.M.

A digest of a text recently published in Russia

Introduction

The account of the diamond fields of Yakutia in Northern Siberia already published in the MAGAZINE [1] can now be supplemented by a digest of a book published in Moscow last year.[2] This text may be considered to supplement P. A. Wagner's "Diamond Fields of Southern Africa" and A. F. William's "The Genesis of the Diamond" with much new information and many re-interpretations of facts already known; it also records a remarkable scientific and engineering achievement. Western Yakutia, where the diamond fields are, is nearly 4,000,000 sq. km. in area or about twice as large as South-West Africa and South Africa combined. Snow lies from the end of September to mid-May and the average monthly temperature is above freezing point in only five months of the year. Larch forests cover most of the country and only thin out to forest tundra north of the Arctic Circle. Transport is mainly by air as there are virtually no roads and few of the rivers are navigable except during the spring and summer floods. The nearest point on the

[1] DAVIDSON, C. F. THE MINING MAGAZINE, Dec., 1957.

[2] "Almaznye Mestorozhdeniya Yakutii." By A. P. BOBRIEVICH, M. N. BONDARENKO, M. A. GNEVUSHEV, L. M. KRASOV, G. I. SMIRNOV, and R. K. YURKEVICH. Scientific Editor: Academician V. S. SOBOLEV. Cloth, octavo, 525 pages with coloured frontispiece, 28 coloured plates, 13 coloured maps and sections, 305 photographs, drawings, and diagrams, and 116 tables. Price 52r. 30k. Moscow: Gosgeoltekhizdat, 1959.

Trans-Siberian Railway is 1,000 km. away. Population is very scanty and until the diamond discoveries there were only about 20 settlements in the whole of western Yakutia.

Exploration and Discovery

A few diamonds were found in placers towards the Yenisei headwaters in Krasnoyarsk from 1898 onwards and one diamond was recovered on the Yenisei Kryazh in the same general neighbourhood in 1937. The finds hardly encouraged further prospecting. Yet V. S. Sobolev after an intensive study of Wagner's, Williams's, Verhoogen's, and G. I. Williams's publications on South and Central African diamond fields and from his knowledge of Siberian Platform geology and of the alkaline basic extrusives and flood basalts occurring there said in 1940: "Speaking of South Africa, the closest resemblance we have to the South African Platform is the Siberian Platform between the Yenisei and the Lena." In the same year he wrote in a report: "Every expedition working in the north of the Siberian Platform must devote serious attention to search for kimberlite and diamonds. Special attention ought to be given to the noble metal placers in the Noril'sk Field and on the Vilyui."

Courageously Sobolev followed that up in 1941 with an address to the U.S.S.R. State Planning Commission on the necessity for diamond prospecting on the Siberian Platform and particularly in the Vilyui valley. As a result of his advice large-scale systematic geological investigation of western Yakutia for economic diamond deposits began directly after the European War ended in 1945. In 1953, after eight years that must have tried him severely, workable diamond gravels were found in the Vilyui basin. Subsequent discoveries have been the unpayable Zarnitsa Pipe in 1954, about 15 pipes (the payable Mir and Udachnaya Pipes among them) in 1955, and other pipes and dykes in the Olenek, Muna and Aldan drainages in 1958. Altogether about 120 kimberlite pipes and dykes, arranged in groups in five fields, 150–700 km. apart, were known when the book reviewed here went to press. No sills are described

Geological Location

Most of the Siberian Platform lies between the Lena and the Yenisei and a zone of fractures separates it from bordering folded rocks on the south-west, south, south-east, and north-east. Overlying the Archaean and Proterozoic rocks of the Platform are epicontinental marine Cambrian to Permian sediments and continental Mesozoic sediments, some of which are of volcanic origin. Tuffs and flood basalts (traps) of Permian to Triassic, or even Lower Jurassic, age outcrop mainly in the valleys of the Lower and Stony Tunguska and Vilyui and relate to dolerite and dolerite-gabbro intrusions. Coloured geological and structural maps to scales of about 1 in 15,000,000 in the text show the main features of the Platform; other coloured maps to scales varying from 1 in 300,000 to 1 in 2,000,000 give rather less generalized geology in four of the five kimberlite fields, although not the actual positions of the kimberlite extrusions or of the alluvial diamond workings.

The main Palaeozoic and Mesozoic structures affecting the five known kimberlite fields are (from north to south) as follows: Olenek and Muna, Olenek Sag; Daldyno-Alakit, Tunguska Downwarp; Malaya Batuobiya, Angaro-Vilyui Imposed Sag; Aldan, Aldan Upwarp. Zones of fractures cross the Platform and one N.E.-trending set passes through the Malaya Batuobiya Field, which is situated within about 70 km. of the junction between the Palaeozoic Tunguska Downwarp and the Mesozoic Angaro-Vilyui Imposed Sag. Probably the Platform structures, seldom at all pronounced, are conditioned by deep dislocations in the Archaean basement. Prevailing strikes in the Archaean of the Anabar Upwarp are N.W., but, as might be expected, with so many superposed structural systems, kimberlite dykes, pipe elongations, and lines of pipes do not favour any single direction, nor do their dispositions appear to be influenced by the dolerite dykes, some of which strike N.W. and are traceable for tens of kilometres.

Only the Mir Pipe in the Malaya Batuobiya Field and the twin Udachnaya Pipes in the Daldyno-Alakit Field contain diamonds in amounts payable by Russian standards, although in the Muna Field some of the pipes approach payability. Details about the Sputnik Pipe recently found close to the Mir Pipe have still to be released. Most of the pipes seem to be on the small side, but the dimensions of the Mir and twin Udachnaya Pipes can perhaps be guessed from scaleless drawings as about 500 m. by 350 m. and 1,000 m. by 500 m. Of 26 pipes where full enough information is given two out-

cropped as kimberlite and the rest were covered by up to 5 m. of eluvium. Methods resulting in the discovery of the masked kimberlites were as follows: Panning for companion minerals of diamond 7, magnetometry 15, aerial photography 1, aerial magnetometry 1. Most of the original discoveries in 1954 and 1955 seem to have been made with the pan; applications of geochemistry are not mentioned at all. Probably numbers of kimberlite extrusions remain to be found.

The weights of the diamonds recovered from the kimberlite extrusions vary from tenths of a milligram. to 54 metric carats. In the Mir Pipe distribution of the diamonds by size is as follows: *Plus* 4 mm., 1–2%; 2–4 mm., 15–20%; 1–2 mm., 50–60%; *minus* 1 mm., 10%. From each of the Mir, Zarnitsa, and Udachnaya Pipes large samples of diamonds were taken. The crystals in each of the samples were weighed and measured individually (for the Udachnaya Pipe dimensions were obtained by applying a conversion factor to the observed weights) and the results were used to plot (1) diamond weights and (2) average diamond dimensions against the percentage numbers of stones corresponding to them. Thus in the Udachnaya Pipe 2-mm. stones account for about 7% of the total recovered and the two figures give a point on the curve of distribution by average dimensions for that pipe. The weight and dimension curves for the Mir Pipe in the Malaya Batuobiya Field differ radically from the two sets of counterparts (both very like one another) from the Udachnaya and Zarnitsa Pipes in the Daldyno-Alakit Field. Other investigations, based on exploration to depths of about 12 m. in pipes with various altitudes above sea-level, are held to show that diamonds are distributed in plan at random through the kimberlite intrusions (which so far seem to be devoid of accidental inclusions larger than 5 m. in size) and that they do not become smaller towards pipe walls. The inference is drawn that the diamonds must be xenocrysts in the kimberlite.

Geological Age and Search Methods

The age of the Siberian kimberlites has not been finally settled. The picrite porphyry, augitite, nepheline basalt, limburgite, ijolite, melteigite, and dunite in the north of the Siberian Platform are contemporaneous with the flood basalts or trap rocks which contain xenoliths of kimberlite although they themselves in places form xenoliths in that rock. Jurassic sedimentary xenoliths have nowhere been recorded from kimberlite, hence it must be pre-Jurassic. Discoveries of diamantiferous, possibly Permian, friable sediments in the River Markha indicate that kimberlite vulcanism may have started in, or before, Permian times, but it appears that the main activity was in the Triassic. Radiogenic age determinations on protomagmatic minerals, cognate xenoliths, and xenocrysts are not mentioned, although they would be of the greatest interest and might decide whether the protomagmatic minerals are, in part at least, cognate xenocrysts.

Although most uncompacted formations in western Yakutia contain some diamonds placers with significant concentrations are fairly rare and rich ones very rare. Workable diamantiferous gravels are all of Quaternary or recent age, though it appears that Mesozoic and Tertiary formations have played important parts as collectors. Most of the diamonds are won from the stream valleys; concentrations in the five successive terraces that have been distinguished are of no importance except in the Yirèlèèkh, where they are rich, and in the Markha, where they are low-grade but extensive. Interesting figures for the *relative* concentrations of diamonds in the Markha terraces are given. Starting with the stream gravels and lowest terrace they are: 2·7, 2·1, 1·2, 0·9, 0·4, 0·3. Figures for diamond distribution according to average dimension in the Yirèlèèkh gravels are as follows: 0·5–1 mm, 20%; 1·0–2 mm, 55%; 2·0–4 mm, 25%; 4·0–8 mm, negligible. The richest diamantiferous gravels are in the immediate vicinity of kimberlite extrusions or of rich "collectors." Downstream from sources diamond contents and the average weights of the stones fall fairly rapidly. Although much of the surface of Yakutia is limestone, ancient diamantiferous river channels of Lichtenburg type seem not to have been discovered; even if they were prospecting and working would be difficult as permafrost extends down to 350 m.

When searching for kimberlite by panning the main indicator minerals are pyrope, magnesian ilmenite (picro-ilmenite), olivine, and chrome-diopside. Attempts to establish the greatest distances to which pyrope can be traced from particular kimberlite sources have not been very successful as neighbouring uncompacted sediments interfere by shedding the mineral. Quantities of pyrope and picro-ilmenite decrease little for 1·5 km. below the Zarnitsa Pipe although grain-sizes

shrink in that distance to a fraction of a millimetre. Tests in a revolving drum filled with water and faced internally with cement containing pieces of chalcedony, quartz, and quartzite showed that after revolutions equivalent to 155 km. of travel down an average Yakut stream inputs of pyrope and picro-ilmenite had all been ground fine and reduced in amount by 90%. A rhomb-dodecahedron of diamond was quite unaffected by a similar test and would therefore survive to much greater distances than its companion minerals. Picro-ilmenite is less resistant than pyrope, but both minerals lose weight fastest during the early stages of the journey when they are still angular or sub-angular. Close to a kimberlite extrusion pyrope sometimes retains its kelyphitic crust; the characteristic resorbed surfaces tend to persist a little farther. Some kimberlites bear little pyrope; picro-ilmenite may then be used as a tracer, especially if there are no trap rocks or ilmenite-bearing sediments in the neighbourhood. Picro-ilmenite is in places distinguishable from platy trap ilmenite by its occurrence in coarse roughly spherical grains with leucoxene coatings and adherent tiny perovskite crystals. The magnesia and chrome contents serve to identify it chemically. Olivine seldom persists more than 5–6 km. downstream from its kimberlite source; chrome-diopside, because of the readiness with which it cleaves, is unlikely to survive for more than a few hundred metres.

Kimberlite Types and Xenoliths

Six main types of kimberlite are described. They are:—

(1) Kimberlite tuff (Mir) with crystalloclastic texture, much pyrope, subordinate picro-ilmenite, and sporadic chrome-diopside and perovskite.

(2) Kimberlite breccia (Zarnitsa) containing on an average 50–60% accidental inclusions with a few cognate inclusions. Pyrope is subordinate and picro-ilmenite dominant

(3) Basaltic kimberlite with much fresh olivine.

(4) Magmatic kimberlite with basaltic appearance, the porphyritic texture typical of an effusive and the rudiments of flow structure. It is without pyrope and fresh olivine but contains significant amounts of perovskite.

(5) Lamprophyric mica-rich kimberlite occurring as magmatic fragments in breccia.

(6) Transitional kimberlite containing appreciable quantities of apatite and perovskite. Mica, which is in the groundmass, is less abundant than in Type (5).

Types (1) to (4) are mica-poor and relate to Wagner's basaltic kimberlite. South African kimberlites closest to those of Types (5) and (6) would be found at the Lion Hill Dyke and the Frank Smith Pipe. Apart from mica, important in Types (5) and (6), and accidental and cognate inclusions, all the types consist mainly of a first generation of coarse serpentine pseudomorphs after olivine and a second generation of smaller olivine crystals which has been carbonated and serpentinized.

Xenoliths in the kimberlites are classed as (1) ultrabasic, feldspar-free rocks, (2) crystalline "schists," including feldspar-free eclogites and feldspathic eclogite-like rocks, (3) basic trap rocks, and (4) sediments. The first class, in which all the rocks are cognate with kimberlite and garnet-bearing, has been subdivided into (a) pyroxenites, including enstatitites and websterites, (b) hornblendites, (c) peridotites, (d) porphyritic peridotites, (e) dunites and olivinites, (f) serpentinites, and (g) glimmerites. Ferrous components in the olivines of the olivine-bearing rocks vary from 8–12% and in the monoclinic pyroxenes from 19–22%. Exceptions are the non-porphyritic peridotites where the ferrous components of the olivines and monoclinic pyroxenes are from 16–28% and 23–30%. The pyrope component in the dichroic garnets of (1c) and (1d) and of the enstatitite varies from 50–75%. In the second class belong (a) rocks of the eclogite facies, (b) rocks of the garnet-amphibolite facies, (c) crystalline schists and gneisses of the Archaean Complex. The eclogite facies includes, first, typical eclogites, consisting of dichroic pyrope (50–85% pyrope component) and chrome-diopside or monoclinic pyroxene (10–20% ferrous component) with, or without, small quantities of plagioclase, kyanite, and graphite; secondly, eclogite-like rocks composed of garnet (35%–60% almandine component), monoclinic pyroxene (22%–50% ferrous component) and 10%–40% plagioclase, with or without kyanite or hornblende, and, thirdly, grossular-pyroxene-kyanite rocks. The typical magnesian eclogites and the grossular-pyroxene-kyanite rocks could have formed only at very high pressures. Recently a diamantiferous eclogite was unearthed in the Mir Pipe and there is tenuous evidence in the text, although no

explicit statement, that it belongs to the magnesian variety and is not eclogite-like.

Genesis.—A synthesis of the authors' opinions (which conflict slightly as might be expected in a field so recently discovered, where only two pipes have been worked or deeply drilled) on kimberlite evolution and genesis follows. Kimberlite magma formed below the hearths of trap magma at great depths in the upper levels of the peridotite layer; pressures and temperatures may have been of the order of 50,000 atmospheres and 1,500° C. The kimberlite and the trap were not co-magmatic, as the ferrous components of their olivines differ by 10%. Nevertheless, they both depended for their genesis on features peculiar to the development of the Siberian Platform. After formation the kimberlite magma penetrated upwards through cracks; it was no longer in equilibrium with pyrope and picro-ilmenite and as a result those minerals developed kelyphitic borders and leucoxene coatings where they were in direct contact with it. Fragments of magmatic kimberlite in kimberlite breccia contain Palaeozoic limestone xenoliths that have been marmorized, phlogopitized, magnetitized, and serpentinized, but no such alterations are found in similar xenoliths in contact with the breccia itself. The inferences are that the temperature and pressure fell slowly as the magma rose to within a few kilometres of the surface and then very rapidly as it blew a passage through the remaining rock layers with a final brecciating explosion. More than one explosion may have taken place in some pipes as there are signs of successive solidifications and brecciations and several phases of kimberlite in them. Repeated brecciations would make the rocks subject to it more porous and so would facilitate the circulation of hydrothermal solutions.

The garnet of the kimberlite originates not only from the feldspathic eclogite-like rocks comparatively poor in magnesium but also from the much deeper peridotite layer, where the more magnesian varieties of eclogite-bearing garnets rich in pyrope may belong. Pressures in the magma during its ascent and before the final explosion may have caused some eclogitization of crystalline "schists" in the wall rocks, but shortly before the explosion they must have fallen below 25,000 atmospheres, otherwise quartz in contact-metamorphosed "schists" would show traces of transformation to coesite. The tuffs of the Mir Pipe are rich in pyrope but contain no crystalline "schist" or eclogite-like xenoliths; it is therefore supposed that the final explosion in that pipe may have taken place above the level of the "schists" and that the pyrope was all transported from great depths.

Undoubtedly the diamonds themselves were transported into their present positions and either crystallized at pressures and temperatures of the order of 50,000 atmospheres and 1,500° C. in the magmatic hearth or already existed in the peridotite layer adjoining it.

In almost all pipes the most widely distributed minerals, apart from serpentine, are olivine, picro-ilmenite, and magnetite. Pyrope is found in the majority of pipes. Chrome-diopside, enstatite, chromite, apatite, zircon, hornblende, and perovskite are ordinarily present in single grains or in xenoliths. The basic distinction between various types of kimberlite is their olivine (in contradistinction to serpentine) content. Kimberlite breccias, easily permeable and serpentinized, contain only scattered grains of the mineral whereas basaltic kimberlites may contain as much as 19% of it. On the other hand, in basaltic kimberlite the contents of picro-ilmenite and pyrope are lower than in kimberlite breccia. Carbonation and serpentinization of the groundmass are characteristic of all kimberlite, but the intensity of carbonation tends to decrease in depth.

Mineralogy

Kimberlite minerals are divided into those (1) of the kimberlite itself, (2) included in it as xenocrysts, and (3) resulting from secondary processes. The first division embraces protomagmatic, or introduced, minerals, as well as those of the groundmass. In the second division come, first, minerals derived from xenoliths cognate with kimberlite and, secondly, those from xenoliths not cognate with it, or accidental. Secondary minerals are divided into automorphic, hydrothermal, and supergene. Protomagmatic minerals with (except for diamond) characteristically high magnesium contents and small amounts of chromium, nickel, and cobalt are not readily distinguishable from cognate xenocrysts. Supposedly they crystallized comparatively undisturbed at high temperatures and pressures in the magmatic hearth; their coarseness gives the kimberlite in which they occur a porphyritic appearance. Rounded and oval shapes prevail and resorption surfaces are common as are inclusions of the minerals in one another—*e.g.*,

Table 1.

Kimberlite Minerals.		Xenocrysts.		Secondary Minerals.		
Proto-magmatic.	*Groundmass.*	*Cognate.*	*Not Cognate.*	*Auto-metamorphic.*	*Hydro-thermal.*	*Supergene.*
Diamond	Olivine II	Pyrope-almandine	Alamandine	Serpentine	Calcite	Hydroxides of iron
Olivine I	Monoclinic pyroxene	garnet	Andradite	Serpophite	Dolomite	Kerolite
Picro-ilmenite	Phlogopite II	Grossular	Grossular	Magnetite	Aragonite	Vermiculite
Pyrope	Apatite	Olivine	Diopside-hedenbergite	Chlorite	Serpophite	Azurite
Enstatite	Perovskite	Diopside	Hypersthene		Magnetite	Malachite
Diopside		Chrome-diopside	Plagioclase		Pyrite	
Chrome-diopside		Plagioclase	Potash feldspar		Pyrrhotite	
Chromite		Potash feldspar	Ilmenite		Sphalerite	
Spinel		Pleonaste	Biotite		Galena	
Magnetite		Rutile	Hornblende		Chalcopyrite	
Graphite		Zircon	Apatite		Millerite ?	
Phlogopite I		Kyanite	Zircon		Celestine	
		Sapphire	Magnetite		Barite	
		Moissanite	Graphite		Strontianite	
			Quartz		Quartz	
					Chalcedony	

in Siberia graphite, olivine, and pyrope in diamond and in South Africa, diamond in olivine, pyrope, and chrome-diopside. The inclusions indicate that the minerals concerned crystallized more or less at the same time and under similar physico-chemical conditions. Groundmass minerals are idiomorphic, fine-grained, and usually so intensely altered that, *e.g.*, unserpentinized olivine is a rarity. They probably crystallized as the magma rose through cracks towards the surface. Table 1 sets out lists of the minerals in the various categories.

Of the protomagmatic minerals, olivine is often intergrown with pyrope, picro-ilmenite, and magnesian chromite and may occur, as mentioned, as inclusions in them and in diamond. The ferrous component varies from 7%–13% and there are traces of chromium, cobalt, and nickel. Picro-ilmenite in large grains usually consists of aggregates with granular fracture although the exceptional single crystals fracture conchoidally. A pitchy-black colour is characteristic. Encrustations of perovskite and linings of that mineral in cracks are common. Picro-ilmenite is distinguished from trap ilmenite by containing 8%–9% of magnesia. Absence of ex-solution haematite in spite of a high ferric oxide content probably points to quenching by rapid fall in temperature.

Protomagmatic and xenocrystal pyrope are considered together as there is some confusion between them in the text. Grains are rounded and slightly flattened with resorbed surfaces and characteristic fine cracks. Colours vary from colourless, lilac, violet, and raspberry in the more magnesian varieties to orange-red in almandine-rich crystals. Dichroism is strongest in chromium-rich pyrope associated with moissanite in cognate ultrabasic inclusions and less so in chrome-diopside-bearing eclogites. Orange-red almandine-rich varieties probably derive from eclogite-like xenoliths. Garnets with more than 69% of the pyrope component contain 0·3%–4% of chromium trioxide and traces of nickel, cobalt, and vanadium. Chemical and X-ray analyses are the only foolproof methods of identification, although if the grossular content is negligible garnets with refractive indices less than 1·767 are likely to be pyrope. Diopside and chrome-diopside are recorded from almost all the kimberlite extrusions investigated. The colour varies from light yellow-green to dirty bottle-green and the chromium trioxide content from 0·1%–3%. Mostly the minerals probably come from cognate ultrabasic xenoliths and from eclogite, but they could also have crystallized at the same time as the protomagmatic minerals.

Perovskite is one of two minerals in the groundmass that receive attention. Present in all pipes, the quantity is highest in the Muna kimberlites and in about half a dozen extrusions in other fields. The mineral forms small (0·02 mm.–0·2 mm.) idiomorphic crystals of cubic habit, or less often of irregular shape. Spectrograms show that magnesium, niobium, and iron are present as well as calcium and titanium.

Of minerals belonging specifically to the cognate xenoliths moissanite is the most interesting. The mineral was detected in a rounded xenolith of porphyritic peridotite consisting of pyrope phenocrysts and pseudomorphs of serpentine after olivine and enstatite and of carbonate after monoclinic pyroxene ; the groundmass was of olivine

hydrothermally altered to serpentine and carbonate. Moissanite is grey, with an adamantine to metallic lustre, specific gravity of 3·1, and a hardness on the Mohs scale above 9. Unlike diamond it does not burn in a stream of oxygen at a temperature of 1,100° C. Crystals are hexagonal with refractive indices in sodium light of 2·655 (No) and 2·697 (N_E). Spectrograms show that iron, magnesium and aluminium are present. Because of its hardness and chemical stability the mineral survives transport in eluvium and alluvium to considerable distances.

Secondary carbonates are widespread in the groundmass of the upper parts of most kimberlite pipes and also as lenses, veinlets, and pockets. Calcite containing less than 1% of magnesium predominates; aragonite and strontianite occur in small quantities, but not magnesite. The calcium is thought to infiltrate into the kimberlite from limestones near the surface. In spite of the secondary hydrothermal barite, strontianite, and celestite in kimberlite " favas " are not recorded from neighbouring eluvial and alluvial deposits. Probably they form only as lateritization products in tropical conditions.

Diamond Types.—Except for a few cubes all the Yakut diamonds are octahedra, rhomb-dodecahedra, or transitions. The rhomb-dodecahedra and transitions are regarded as resulting from laminar growth on octahedral faces. Regular forms are rare and those that appear so often turn out on closer inspection to be shrunken along one of the axis of threefold symmetry or elongated in the direction of one of the twofold axes. Laminar growth structures, starting antiskeletally, from face centres, are very characteristic. Octahedral growth is by superposition of trigonal and ditrigonal laminae and in its course triangular cavities develop on faces and parallel and sheaf-like striae form at their edges. The thin laminae bear witness to a cyclic course of crystallization, but thicker ones may depend not upon the normal rhythm of deposition but on general changes in concentration, pressure, and temperature. In octahedra twinning is according to the spinel law and produces macles flattened in the direction of the threefold axes of symmetry. There are also a few cubes twinned on the octahedron face. Regular and irregular intergrowths and aggregates and inclusions of diamond within diamond are described.

Common structures on diamond faces are: (1) Inverse parallel triangular cavities, (2) inverse parallel hexagonal cavities, (3) tetragonal figures and patterns at octahedral vertices, and (4) columnar and " tiled " structures. Inverse parallel cavities are attributable to growth on a face from several foci simultaneously or to obstruction of growth by some mineral other than diamond. Tetragonal negative pyramids develop at the vertices of smooth-faced, sharp-edged octahedra without visible laminar structure, as well as in laminar crystals where groups of the pyramids are characteristic. " Tiled " and columnar structures are peculiar to dodecahedral crystals. The " tiles " cover the faces with the semblances of flakes overlapping one another in the direction of emergence of the threefold symmetry axis. Columnar structures are linked by gradual transitions with so-called " splintery " striae and develop only on crystals with ditrigonal growth layers. The ends of the columns are rounded.

Diamonds bearing traces of corrosion or solution are rare. Crystals in the early stages of corrosion appear as if frosted, although the colourless, transparent, interiors may show through in patches. Frosting normally affects the whole crystal including any triangular growth cavities there may be upon it. As corrosion progresses the whole crystal turns white and its surface is seen to be composed of small irregularly-rounded eminences or of trigonal pyramids with common orientation. Some inverse parallel triangular cavities may also form, though they have not been observed, but only by the juxtaposition of three corrosion pyramids. Spotty frosting and frosted crystal fragments may indicate that the agent causing the frosting was gas percolating through porous kimberlite or kimberlite breccia. Diamonds frosted by transport in streams are described but are rare. Their edges and vertices are generally rounded and covered with a web of fine scratches and with little dents. In the early stages growth cavities on crystal faces are unaffected.

Diamond Classification

For practical purposes Siberian diamonds have been classified in nine types according to morphology. The types are: (1) Flat-faced octahedra; (2) crystals in which successive trigonal growth laminae shrink in area outwards from the crystal centres; (3) crystals with polycentric growth faces; (4) crystals formed of thin ditrigonal growth laminae; (5) crystals of rhomb-dodecahedral or transitional habit with " splintery " striae at their edges; (6) crystals, generally of

octahedral or transitional habit, with rounded faces; (7) block structure crystals, usually octahedral though they may be transitional, with faces bounded by curved surfaces intersecting in curved lines and forming blocks; (8) rounded crystals formed from rhomb-dodecahedra with convex faces sutured along the short diagonals of the rhombs, and (9) cubic crystals. There are transitions between Types (3), (6), (7), and (8). The classification is not exhaustive, nevertheless 70%–90% of the diamonds mined fit into it and it has been used to analyse the outputs from kimberlite and gravel mines set out in Table 2. Indications are that crystal habits do not develop at random, but depend upon the effects of external factors during growth. In a particular deposit most of the output belongs to three or four types. The dominant type has the largest stones and stones of the other types differ from the dominant one and among themselves in average weight. Morphology and other qualities such as transparency, colour, kind of luminescence in ultra-violet rays, and frequency of inclusions are related to some extent.

In Table 2 similarities in the classifications of the diamonds from the Mir Pipe and the Middle Vilyui gravels, both of which are in the Malaya Batuobiya Field, are at once apparent. The Udachnaya and Zarnitsa Pipes are both in the Daldyno-Alakit Field and the classifications of their outputs resemble one another closely, but differ markedly from those of the Malaya Batuobiya Field. Peculiarities in the classifications of diamonds from the Ygyatt and Morkoka gravels may point to undiscovered kimberlite sources in their neighbourhoods. In the Markha, Tyung, and Muna drainages kimberlites are already known to exist.

Morphological statistics, average weights of diamonds, and kimberlite petrology all indicate that extrusions in a particular field originate from a common hearth. As already said, the evidence favours the derivation of the diamonds from the hearth or its surroundings and is against their crystallization in the extrusions themselves. From the south-west of the Siberian Platform towards the north-east average sizes of diamonds fall, as do the percentages of smooth-faced octahedra and graphite-cemented aggregates. On the other hand, in the same direction the percentages of rhomb-dodecahedra and rounded diamonds rise and so do the number of crystals that luminesce in ultra-violet light. It is suggested that if laminar octahedra indicates rapidity, and rounded crystals slowness, of growth then the Mir diamonds in the south-west must have crystallized faster than those towards the north-east of the Platform. Possibly pressure in the Mir magma reservoir fell sharply before all the carbon had crystallized out as diamond and the remainder separated as graphite. To the north-east of the Platform crystallization may have gone on uninterruptedly, but as the pressure gradually fell the areas of the growth faces deposited shrank, with the production of the rounded crystals which are the final growth form.

Inclusions of graphite impart to Yakut diamonds in large parcels a greyish tint rather like that of coarsely-crystalline rock salt. Clearly-coloured crystals are rare and particularly so if the coloration is strong. Greenish-yellow stones amount to 0·5% and 0·3% of the outputs at the Mir and Udachnaya Pipes. Inky-violet diamonds are confined to the Mir Pipe, where they make up 2% of the output. Other colours, in order of increasing rarity, are aquamarine, light bottle-green, pale red, and pinkish-mauve or brown. Yellow and greenish-yellow diamonds are quite distinct morphologically from other diamonds, as 65% of them are cubes and combinations of cube, octahedron, and dodecahedron and 27% octahedra with faces covered by a dense pattern of inverse parallel triangular growth cavities. The coloration is caused by traces of ferric iron with contributions in some crystals by titanium; it may be limited to an outer shell. Violet diamonds have linear patterns of inverse parallel triangular cavities along cleavages and invariably contain iron in amounts which do not vary with depth of colour. The main chromophore has not been established, although there is a suspicion that it may be graphite. Green, bluish-green, and tobacco-brown spots are thought to be attributable to irradiation. Superficial yellowish and reddish tints result from infiltration of ferric oxide into cleavages and cracks and are secondary phenomena.

Some diamonds do not fluoresce in ultra-violet rays at all, but others do so in shades of blue and in yellow, green, orange, yellowish-red, and pink; those not fluorescing are deep smoky yellow or brownish-yellow. Yellow fluorescence and absence of fluorescence may be due to the screening effect of the crystals' natural colours. Relationships have been established between colour and intensity of fluorescence and purity, trans-

Table 2.

Percentages of Outputs by Numbers.

Morphological characteristics of crystal	Pipes			Alluvial deposits							
	Mir	*Udachnaya*	*Zarnitsa*	*Middle Vilyui*	*Upper Vilyui*	*Ygyatt*	*Middle and Lower Markha*	*Morkoka*	*Alakit*	*Tyung*	*Upper Muna*
(1) Flat-faced octahedron .	18·6	4·3	6	19·5	5·0	14	6·0	10	3	2·3	1·0
(2) With trigonal growth laminæ shrinking in area outwards . .	2·7	7·7	9	1·6	—	5	6·1	—	2	4·5	1·4
(3) With polycentric growth faces . . .	29·1	6·8	8	23·9	28	10	4·2	9	6	8·6	3·8
(4) With thin ditrigonal growth laminae .	14·6	6·8	2	15·8	19	12	20·3	6	12	5·6	14·8
(5) With "splintery" striae	25·5	60·8	53·0	14·0	20	32	30·7	31	42	6·1	27·1
(6) With round, stepped, faces . . .	3·8	1·6	2	8·5	—	10	5·1	9	—	7·4	—
(7) With block structures .	2·8	5·7	4	5·7	6	5	16·2	18	2	11·9	2·9
(8) Rounded . . .	—	4·9	9	4·8	20	7	5·2	15	26	45·6	40·0
(9) Other types . .	2·9	1·4	7	6·2	2·0	5	6·2	2	7	8·0	9·0

parency, and morphology. The number of diamonds fluorescing blue tends to increase progressively from flat-faced octahedra to rounded rhomb-dodecahedra and from coarsely laminar crystals to those that are thinly laminated and have block structures. These progressions agree well with the belief that diamonds build themselves up by growth processes. The percentages of diamonds fluorescing in different colours vary according to the fields from which they come. For example, the average number of diamonds fluorescing in blue from all fields is 62%, but from the Mir Pipe it is 41%. Further, at the Mir Pipe 41% of the diamonds either do not fluoresce at all or only do so faintly, whereas the corresponding maximum figure for other fields is 27%. Fluorescence is used widely at mines in the recovery of diamonds from heavy mineral concentrates; it also helps to grade them as abrasives. Those that do not fluoresce are the hardest, pale-blue fluorescers the softest, and yellow fluorescers intermediate. Adopting the nomenclature of Robertson, Fox, and Martin, most stones belong to Type I, the remainder being of Type II, or not corresponding well with either type. The results of Russian investigations do not support Raman's theory.

The great majority of Yakut diamonds are anisotropic to some degree and this anomaly is explained as the effect of the same rapid quenching that inhibited the ex-solution of ferric oxide from picro-ilmenite.

Principal inclusions in diamonds are olivine, garnet, and graphite, with chrome-diopside, brookite, or rutile and gas bubbles as possibilities. Olivine inclusions contain about 6% of the fayalite component and are surrounded by cracks (which may be filled with graphite) resulting from the difference in the coefficients of volumetric expansion of the two minerals. Garnet from inclusions is pyralspite with a large pyrope component. Crystal faces are often convex, though the edges may be sharp. Graphite seems usually to enter crystals after their formation, but the origin of the graphite that impregnates diamond grains at the centres of polycrystalline growths is uncertain. Inclusions of diamond within diamond are rare and are either irregular or well-defined octahedra; they may have triangular growth cavities on faces and four-sided negative pyramids at vertices. The enclosing diamonds are not cracked.

Concluding their book the authors say; "Many of the ideas set out above are based on limited material and need confirmation from wider and more exact data. Consequently the investigations, the results of which are presented in the present volume, ought only to be regarded as the first stage in the study of Yakut diamond mineralogy." They have certainly made a most impressive start and their book should commend itself to geologists working on platforms, whether largely preserved as in Southern Africa or partly eroded as in Sierra Leone and Guinea.

Quartz for I.C.B.M.

A. E. Williams, Ph.D., F.C.S.

Finely-divided mineral coating used to shield an intercontinental missile

Quartz is generally recognized to be crystalline silica occurring either in prisms capped by rhombohedra (low-temperature or *alpha*-quartz), or in hexagonal bipyramidal crystals (high-temperature or *beta*-quartz). Widely distributed in igneous, metamorphic, and sedimentary rocks, it often occurs in the opaque or " milky " form and, less frequently, as the clear crystals used in optical work and as a gemstone. The opaque, high-temperature quartz has the property of maintaining its resistivity at temperatures much higher than the melting point of metals and because of this it is a good protective medium for equipment projected outside the earth's atmosphere and which it is desired to recover intact. Conventional engineering materials on re-entering the earth's atmosphere would simply burn up before reaching the ground.

Much research work in this field has been carried out all over the world and in the U.S.A., on February 24, 1960, Avco Corporation's advanced design re-entry vehicle, or nose cone, flew successfully on an American Air Force Titan intercontinental ballistic missile (I.C.B.M.). The re-entry vehicle, which re-entered the earth's atmosphere after a flight of 5,007 miles, was designed by Avco's Research and Advanced Development Division, in Wilmington, Massachusetts, and manufactured by the firm's Lycoming Division, of Stratford, Connecticut. Air Force officials announced that it was the first time Avco's new design had flown over the intercontinental range course on a Titan, although the same re-entry vehicle model and heat-shielding materials were used on a long-range Atlas I.C.B.M. flight on January 26.

While many of the details are still on the secret list, it is known that the heat-shielding material used on the re-entry vehicle was " Avcoite," consisting chiefly of specially-prepared quartz in a finely-divided condition, with a binder. Exhaustive tests show that this material withstands temperatures in excess of 12,000° F. To produce " Avcoite " the Lycoming Division's Missile Systems Department must first process quartz, which is received in 4-in. chunks of mineral, until the individual particles cannot be seen by the naked eye. The exact fine-particle size required is still on the secret list, but producing such a fine powder from a relatively hard ore is not an easy task. As quartz has a hardness value of 7 on Mohs' scale it is not quite hard enough to serve as an efficient abrasive, but is sufficiently hard to create problems in trying to reduce it.

During early experimental work Lycoming produced the minute fines by jaw-crushing the chunks to sizes that could be handled in a pulverizing mill, the product from the latter being passed over screens. To produce the required extremely fine particle sizes a correspondingly fine mesh had to be employed on the screens and this seriously reduced output. Very fine screen cloths require excessive agitation to force the fines through, which

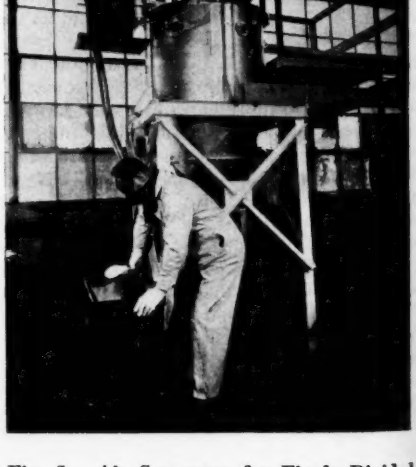


Fig. 1.—Air Separator for Finely-Divided Quartz.

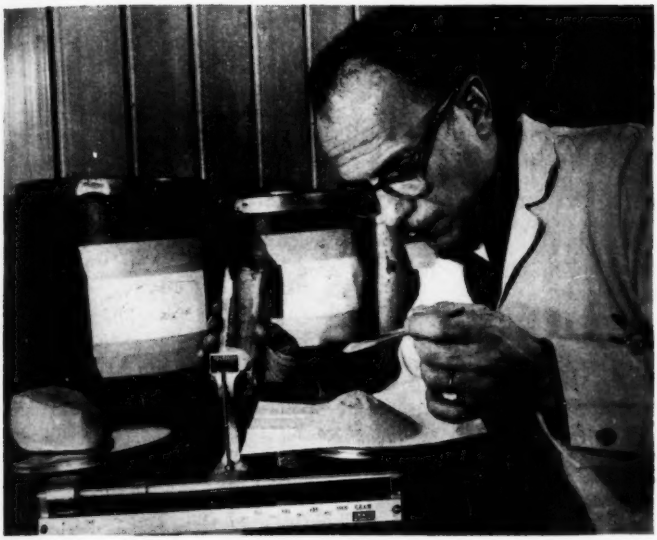


Fig. 2.— Quartz Particles Under Test.

causes wire flexation and ultimate breakage, each breakage meaning leakage of oversize powder into the fines. In addition, with very fine screening, there is always a tendency for the screen to blind over and production ceases until the cloth can be cleaned.

It is now generally recognized that to produce material of fineness of more than about 90 mesh by the use of screens is impracticable. Such features were duly considered by Lycoming and, when " Avcoite " proved its ability to withstand ultra-high temperatures and played a successful role in actual space flights, the firm realized the need for better and faster production.

The bottle-neck in the production line as it stood was in the screening and not in the crushing and pulverizing units. The obvious alternative to screening is air separation, but, as no-one previously had wanted quartz in such a finely-divided condition, it was not at that time known whether the material could be handled efficiently in air separators. At this point Lycoming consulted the Sturtevant Mill Company, of Dorchester, Boston, and trial runs in the laboratories of that company showed that air separation could be quite efficient; that company duly installed a 3 ft. diam. centrifugal air separator in the Lycoming plant (Fig. 1).

The air separator proved to be the complete solution to the problem of obtaining quartz of the required fine-particle size (Fig. 2) with the badly-needed increased production. The bigger throughput was obtained with the same crushing and pulverizing units, as these were found capable of handling the increased quantity of quartz required to keep the air separator in operation. The air separator, as arranged for quartz and other materials, has an external casing (Fig. 3) similar in shape to a cyclone collector and an internal casing which is connected to the outer through an opening in the top and openings in the walls. It is of the central-shaft type, as distinct from the central-tube pattern. The unit's shaft, supported in bearings with a bevel-gear drive on top, is actuated either through a V-belt or geared motor. At the other end of the shaft is a hub with ports and, directly below this, a steel plate. Above the ports is a tube which surrounds the shaft. It is into this tube that the quartz from the pulverizers is introduced. The upper portion of the hub carries another plate, larger in diameter than the lower one, and mounted on it is a series of blades to form a fan. The hub is extended upwards by a tube on which additional fan blades are mounted. Thus, when the shaft is revolved by the motor, the lower plate, the upper plate with its fan blades, and the upper fan revolve. The quartz powder from the pulverizers comes out through the hub on to the lower plate and is discharged into the inner drum, forming an umbrella of miscellaneous-size quartz powder as it is discharged off the revolving plate.

The function of the separator is to draw air

through this falling stream and select therefrom the particles of the desired fineness. This is accomplished as follows :—

The upper, pulling fan, receives its air through the opening of the inner drum and the air is whirled by the upper fan into the outer casing. Any fine-powdered quartz which has been lifted is deposited in the outer casing where it is whirled. Frictional contact with the walls of the outer casing slows down the particles until gravity carries them downwards to the exit at the bottom of the cone of the outer casing. In air separation it is desirable to eliminate dust collectors and to use the same air repeatedly. In practice the stream of " dust "-laden air (the dust being finely-divided quartz) whirls down the outer casing, so causing separation of dust and air. Relatively clean air thus passes back to the inner casing through openings provided with rotating deflectors. The function of these deflectors is to whirl the dust-laden air, so removing the dust. Air thus introduced to the inner drum is whirled by the rotation of the members in the inner drum and, because the upper fan creates a suction, it passes up through the stream of falling quartz powder where the first selection is made. With a constant whirling motion the air moves upwards between the upper large plate and the inner drum inward to the suction side of the fan. Dust-laden air has to pass through revolving blades on the upper plate, which act as rotating sizers. The centrifugal whirl throws outward more of the undesired sizes. The opening at the top of the inner drum directly below the fan may be increased or decreased by the operation of valves similar in action to the diaphragm which controls the aperture on a camera. These valves are operated by a number of levers which extend through the outer casing and they serve to increase or decrease the pull of the top fan.

Several different methods are available to control the particle size of the quartz produced by the air separator. First, by varying the speed of the vertical shaft, the pull of the top fan is affected ; secondly, the volume of air pulled upwards by the top fan can be controlled by opening or closing the diaphragm valves, and last, the number of blades on the upper plate determines particle size of the quartz ; the lower the number of blades the coarser the powder withdrawn and the greater the number the finer the particle size of the quartz recovered. This is because a larger number of blades creates more interference to the inward passage of the quartz-laden air and only the finest particles can get through.

It is well known that air separation is quicker than screening and this was the experience at the Lycoming plant. They found that the air separator produced as much fine quartz in one day as the previously-used screens made in a week and wear-and-tear is

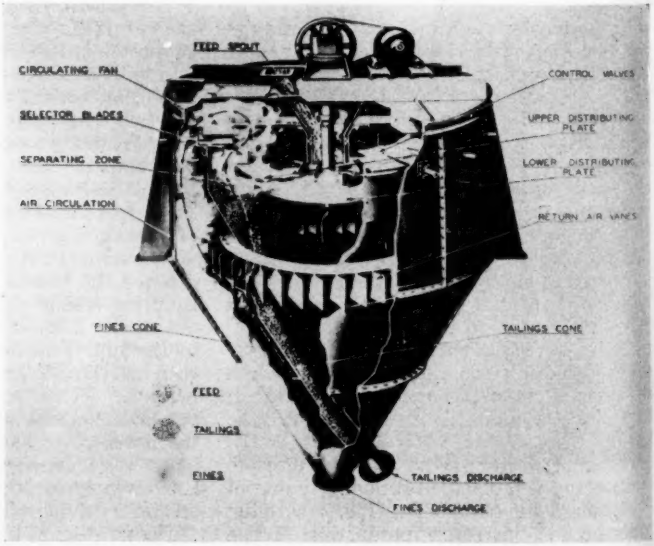


Fig. 3.— Schematic Arrangement of the Sturtevant Air Separator.

negligible since no fine-mesh screens are involved.

In the routine production of the finely-powdered quartz the units engaged chiefly are the pulverizers and air separator, the jaw-crushers serving to break down the incoming chunks of quartz to a size that can be conveniently handled by the pulverizers. The latter units also handle the tailings which are being passed back by the air separator as oversize. In normal running, therefore, there is a constant exchange of material between the pulverizers and air separator ; the latter being the judge as to quality suitable for shipping. As already mentioned, simple adjustments to the separator allow any range of particle sizes to be produced to meet current requirements.

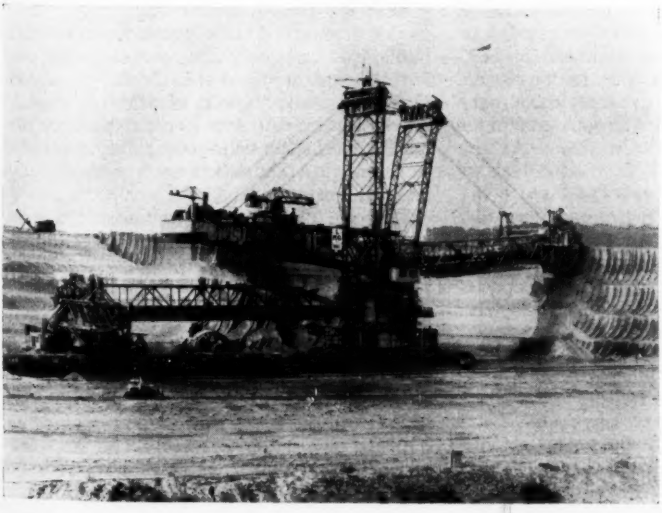
The finely-divided quartz which is passed as suitable by the separator then goes through a magnetic separator for the elimination of any metallic material that may be detrimental to " Avcoite." The quartz powder is then leached and oven-dried prior to blending with binders and other materials. It is finally stored in 75-lb. batches. No doubt travel in outer space both for humans and freight will become a normal routine in the future and this pioneer work already done in the U.S.A. in the shape of economically producing finely-divided quartz, necessary for the protection of the equipment on re-entering the earth's atmosphere, will be appreciated by future generations as well as those engaged in present activities.

Giant Excavators in Open-Cast Work

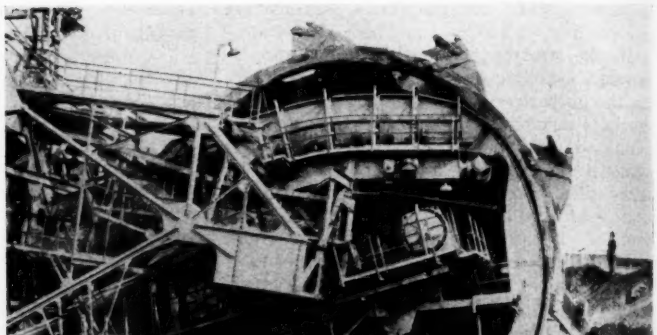
R. J. Salter, B.Sc., A.M.I.C.E.

An account of work done in German brown coal mines

In common with many other developed countries the easily-mined mineral deposits of West Germany are now nearing exhaustion and this has made it necessary to remove increasing quantities of overburden to expose the raw materials beneath. West German mining engineers estimate that by 1965 some 300,000,000 cu. yd. of overburden will have



Excavator at Work on Overburden.



Digging Wheel.

been excavated at depths between 300 ft. and 800 ft. to ensure a steady supply of brown coal alone. By that date the conventional open-cast mine will have been replaced by deep mines, which require greater volumes of excavation and higher stockpiles of excavated overburden.

To solve these problems all the existing excavation and transportation equipment is being replaced by giant items of equipment of entirely new design and which need tremendous financial investment. It is considered that the enormous volume of excavation can only be removed by crawler-mounted, bucket-wheel excavators delivering on to conveyors.

At the Fortuna-Nord open-cast mine, near Garsdorf, one of these enormous machines was first put into service in 1955. At the present time three wheel excavators are at work and a further two machines are being designed. The design of these machines took into account the geological conditions at the mine, where the bed is inclined, faulted, and has numerous waste layers. The proposed maximum working depth is just over 800 ft.

The theoretical output of the machines in use at the present time is 14,125 cu. yd. of loose material per hour, but excavation may be carried out from 165 ft. above to 65 ft. below ground level.

The machines follow the conventional digging wheel excavator pattern, with a maximum length between the digging wheel and the extremity of the digging arm of 623 ft. The diameter of the digging wheel is 52 ft. 6 in. and it has ten buckets, each with a bucket capacity of 2⅓ cu. yd. The speed of revolution of the wheel is 5·4 r.p.m. and it then discharges on to 8 ft. conveyor-belts, the total weight of the machine being in the region of 6,000 tons. The maximum height of the wheel excavator above ground is 216 ft. and the great weight of the machine is spread on to the ground through a bearing area of 437 sq. yd. of tracking.

The disposal of the overburden is by train haulage, side-dump railway trucks being used with a capacity of 144 cu. yd. A normal train consists of seven of these side-dump trucks hauled by two locomotives. At the loading point the train is remotely controlled by frequency-modulated equipment fitted in the belt operator's cabin.

Disposal of the excavated material is by crawler-mounted spreaders. With arms of 328 ft. in length they correspond in capacity with the giant excavating machine. The height of the dumps depends to some extent on the stability of the soil, but with the arm of the spreader fully raised a height of over 120 ft. is possible. Belts on this machine run at speeds of between 1 ft. and 1½ ft. per second and the width is between 7 ft. and 8 ft. Beneath the main carrying-belts are dirt-carting belts with a width of 8 ft. 6 in. and a speed of 3 ft. per second.

Other mines where this type of equipment is operated are the Zukunft-West mine and the open-cast mine Inden, of the Roddergrube, near Julich. Slightly differing equipment and plant arrangement are used in these mines to suit local geological conditions.

Using this type of equipment West German engineers are confident that for many years to come coal-fired power plants will produce cheaper electricity than atomic stations.

Ore-Dressing Notes

(11) *Production.*

Treatment of Blue Ground

A recent paper by E. Colvin and H. S. Simpson[1] describes the treatment of the blue ground at Kimberley diamond mines and reviews changes in concentration methods since the development of the rotary washing pan in 1874. From 1888 the hoisted ore was distributed over " floors "—large areas adjacent to the mines—where it was spread, watered, and harrowed until disintegrated. It then went to small washing plants for concentration, which involved a force of 10,000 labourers and a high security risk. In 1925 gyratory crushers took over and two large washing plants replaced the small units, where from 1932 onwards further modernization led to the replacement of rope haulages by conveyor systems and on to current practice.

To-day ore is hoisted to the crushing plant near the top of each shaft, tramp iron is magnetically removed, and the material screened on 2½ in. before handpicking 2½% of waste from the oversize. Further crushing and screening brings the material down to 1¼in. for transport to the washing plant. This was built in 1958 and can treat 20,000 tons daily. It cost £1,400,000 and has cut operating costs by £60,000 per annum. A tertiary circuit has now been added to those dealing with the two coarser size ranges and this produces over 12,000 carats of inferior quality diamond monthly. The old open-circuit rolls are now replaced by cone-crushers.

Since 1945 exhaustive experiments have been conducted with alternative concentrating methods, but pan washing remains the preferred process. The blue ground carries clayey material which would have to be removed if dense-media treatment were used, but which, in pan washing, makes a natural separating fluid. Ore, from mine or surge stockpile, is fed at *minus* 1¼ in. unsized to the primary concentrating pans, where 80% of the diamond recovery is made. It is first mixed with water in the ratio one load (16 cu. ft.) to 230 gal. to produce a slurry of density 1·26 to 1·28. The floating portion overflows the inner weir of the pan to be screened at ⅜in. the underflow then being fed to the secondary pans. Oversize is re-crushed to *minus* ⅜ in. and returned to head circuit with make-up water. The amount of material is of the order of 40% of the initial feed. The overflow from concentration in the secondary pans goes to 6-mesh screens, oversize being dumped and undersize cycloned to retain *minus* 6 *plus* 28 mesh; the cyclone overflow is recirculated as " puddle " through the plant.

A washing pan has two concentric walls at 7 ft. and 3ft. radii, the outer wall being 20 in. high and the inner 12 in. The bottom is flat and incorporates a sliding door used when complete cleaning of the pan is needed. A vertical shaft at the axis has ten horizontal stirring arms to which are bolted 52 small triangular teeth which thrust the settled material outward as the slurries flows inward. These teeth clear the bottom of the pan by ¼ in. A single circular tooth at the end of the arm moves settled concentrates to the discharge port in the outer wall. A scraper gear is fitted, which is lowered to the floor when the pan is to be emptied. The teeth are driven at 8 r.p.m., outside peripheral speed being 5·87 ft./min. and inside 2/52 ft./min. Power consumed is from 7 h.p. to 8 h.p. and the rated capacity is 40 loads hourly.

The settling minerals are diamond (s.g. 3·5), with ilmenite, garnet, and diopside. Rakes keep the slurry in semi-suspension so that the lighter minerals escape inward while the heavier ones settle, specific gravity in the pan being controlled at between 1·5 and 1·6. Slip of the slurry is such that the speed of rotation of the slurry is about half that of the pan teeth, save near the pan bottom, where it decreases through frictional drag. Density control is effected from a central panel which works hydraulically-varied valves to change

[1] *J. S. Afr. Inst. Min. Metall*, May, 1960.

the water admission rate. The concentrates obtained at this stage constitute 0·25% of the feed, but for safety's sake a settled cut of 2% is taken, which is cleaned up by dense-media separation and grease tabling. This work is done under security precautions.

Originally Harz jigs (" pulsators ") were prominent in this work. In 1897 experiments were being made with a Wilfley table when the operator noticed that diamonds were adhering to patches of grease which had accidentally become smeared on the deck. This led to the discovery of the grease table, now widely used. Since 1958 the recovery plant has consisted of two main sections, *plus* 10-mesh material being treated by dense-media separation and the undersize (" fine diamond recovery plant ") by grease tabling on two screened fractions—the *minus* 10 *plus* 28 mesh and the *minus* 28 mesh. Some 400 tons of *minus* 1¼ in. concentrates are sent daily from primary and secondary pans and are split at 10 mesh as stated above. The dense-media cone works with *minus* 65 mesh ferro-silicon at the density gradient of 2·85 to 3·12 (bottom) to yield 20% in the sink product, a viscosity of 19 to 20 centipoises being held. Grease tables are in pairs, one working while the other is dressed. Nine tons hourly of D.M.S. sinking product are treated in three screened sizes, the grease being a refined petrolatum having four grades of penetration point, selected to maintain the correct hardness of the arresting surface with respect to the grain size of the diamondiferous feed.

Diamonds are scraped off by hand together with about an equal quantity of gangue. For final cleaning the grease is melted away with boiling water and the diamonds are dried and sieved on 10-mesh. Undersize is wet-milled in a miniature ball-mill, deslimed, degreased in chromic acid, and finished either by flotation or electrostatic separation. Daily production from 13,500 tons of kimberlite is 1·25 lb. of diamond (2,800 carats). The ratio of recovery is thus 20,000,000 to 1.

(12) *Dense-Media Separation.*

Atomized Ferro-Silicon

At the Goslar I.M.D. Conference in 1955 Dr. F. Rodis presented a paper describing atomized ferro-silicon. In a recent article[1] he, with his colleague Dr. J. Cremer, brings the record of the use of this medium up-to-date. The alloy, at 15% silicon, is atomized by steam after tapping from an electric furnace, the particle size being controlled by steam pressure and temperature, together with additives—*e.g.* copper—to the melt. The atomized product is quenched in water, thus giving its spheroids a smooth and hard surface

[1] *World Mining*, March, 1960.

Grease Tables in a Diamond Plant.

in contrast to those produced by comminution. Overall strength and magnetic quality are similar with both methods of preparation. The sharp edges of fragmented particles are focal points for the onset of rusting, which can lead to cementing together of affected particles. This, the authors consider, makes the medium less easily reconstituted after week-end shutdown than is the case with atomized ferro-silicon, which is fully mobile within half an hour of start-up. A further advantage is that the rounded particles cause less wear and tear on pumps. The specific surface for any size being lower, there is less clinging between rounded particles than angular ones. For a given viscosity a higher operating density is practicable with spheroids, the limit with special-grade spheres being a specific bath density of 3·9. There is less loss through drag-out of rounded than of ground ferro-silicon, according to the authors' tests, the reason being less tendency for the spheroids to cling to the mineral being washed. Magnetic properties appear comparable, but it has been found in one operation that residual magnetism of rounded material was sufficiently high to require stronger action in the demagnetising coil through which the flocculated material passed.

(13) *Crushing.*

Mobile Units

An article in the *Canadian Mining Journal* for December, 1959, reviewed the manufacturing position of small mobile crushers to-day. Such outfits are steadily increasing in use, not only for small quarrying projects and exploitation of small-scale mineral deposits but also in connexion with large engineering work requiring a once-for-all production of screened and crushed stone from local deposits. Britain has four main producers of this class of equipment. In one (the "Goliath") the capacity is 30 to 35 tons/hour when crushing down to 1½ in, though setting of the jaw-crusher can yield ¾ in. product at a lower rate. Three separate trailer units can be used. The first does the primary crushing, the second the primary screening and secondary crushing, and the third the final screening into up to seven sizes. The primary unit is a single-toggle jaw-crusher and rolls complete the work, belt-conveyors handling the transport.

Another firm makes four "Kompac" models, giving from 20 to 70 tons/hour. From a steel receiving hopper a plate feeder delivers *via* a scalping grizzly to a double-toggle jaw-crusher. Discharge is belt-conveyed to triple screening and bunkering, from which feed to the secondary crushing unit can be drawn. Here either cone crushing or granulation is available. Diesel power is incorporated in the layout.

The third type, the "Rockranger," is a two-unit outfit. Primary crushing works with a special upthrusting toggle action, as does the secondary section. Impact breakers are available instead and deliver stone of good cubical shape. Screening and binning complete this simple portable outfit.

In the fourth type described in this article, a wide range of layouts is made. Primary and secondary crushing are handled respectively by a single-toggle Pegson unit and a gyrasphere in the 50-ton train. Two screen units are used in the three-unit plant, which is powered by oil engines.

Book Reviews

Mine Ventilation. Edited by A. ROBERTS. Cloth, octavo, x + 363 pages, illustrated. Price 70s. London: Cleaver-Hulme Press, Ltd.

This useful treatise includes a series of sections contributed by five authors who have been attending the Postgraduate School in Mining of the University of Sheffield, the editor being the Director of the School. It is a symposium, of course, and there is a certain amount of overlap, as well as a coal-mining bent in the general argument. Nevertheless the treatment is such that students will readily gain an appreciation of the basic problems connected with underground ventilation and enough practical guidance to understand the economic importance of the subject.

Early chapters review the general conceptions important in dealing with fluid flow and requisite measurements, with the hazards of gas contamination, and the amelioration of dusty work. Succeeding sections deal with the underground climate and air conditioning and then with thermodynamical matters. This leads naturally to fan theory and accounts of four types and then to ventilation survey work. The final sections cover ventilation planning and critically discuss the underground network. There is, in addition, a useful set of appendices dealing with associated problems and providing useful data and charts.

Cemented Carbides. By P. SCHWARZKOPF and R. KIEFFER, in collaboration with W. LESZYNSKI and F. BENESOVSKY. Cloth, octavo, 349 pages, illustrated. Price 105s. New York and London : The Macmillan Company.

The senior author of the work noticed here is Dr. Paul Schwarzkopf, one of those most prominently connected with the development and use of carbide materials in the manufacture of cutting tools. He has been largely concerned with research and industrial development in Europe and the United States, his co-author, Dr. Kieffer, being director of the Austrian plant, with Dr. Benesovsky an associate and Dr. Leszynski doing similar work in New York. These eminent authorities have in their book been able to present the outcome of the work that has made modern high-speed machining possible and to show the many other directions in which the hard cemented carbides can be usefully employed.

In a previous work, published in 1953, and entitled " Refractory Hard Metals," the authors dealt with the pure hard metals—that is, materials that were free of binder material or uncemented. The present book covers the " commercially important composites " of the pure materials and " binder metals of high ductility," as is stated in the preface. Early chapters cover production and give background information, the mechanical and chemical properties of the compounds in commercial production then being subjected to critical review. The final sections give an account of the important uses of the cemented carbides in industry.

Winning Coal. By JOHN SINCLAIR. Cloth, octavo, 406 pages, illustrated. Price 60s. London : Sir Isaac Pitman and Sons, Ltd.

The author of the series of books which includes that noticed here, Dr. John Sinclair, formerly a director of the Hulton Colliery Co., Ltd., in Lancashire, is Professor of Mining in University College, Cardiff. The textbooks referred to are designed to aid students taking their National and Higher National Certificates and to help those taking degree courses or sitting for the qualifying examinations of the Institution of Mining Engineers. The present work covers the various methods of winning coal employed at the present time and is written in a style that will emphasize the necessity for mechanization underground and for efficient handling and preparation at surface if coal is to hold its place as this country's main source of thermal energy.

In the eleven chapters covering his subject the author, after dealing with open-cast work and " hand " mining, goes on to review mechanized methods in all their underground applications in British coal mines. The final chapters deal with breaking techniques, covering the use of explosives and other devices for winning coal.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Uranium Deposits in Finland

For the last year or two there have been rumours of an important uranium discovery in Finland, but no particulars have appeared in Western literature. A special interest therefore attaches to a brief paragraph recently published in *Zeitschrift für angewandte Geologie*,[1] to the effect that uranium-bearing quartzites were discovered in 1957 in the Koli region of northern Finno-Karelia, with indications of ore extending over a distance of 25 kilometres. A beneficiation plant at Paukkanjanvaars which has just come into production is expected to produce initially about 200 tons of concentrate annually, from the milling of 30,000 tons of crude ore with a content of 0·2% U_3O_8. The deposits are no great distance, perhaps about 50 kilometres, from the Russian frontier.

No particulars of the geology of the ore deposits have yet been received, but according to the general literature[2] the Koli rocks (Jatulian series) are of " Proterozoic " age and overlie the " Archaean " granite-gneisses. They comprise a basal quartz-pebble conglomerate succeeded by a series of medium-grained quartzites (usually 300–400 metres, sometimes 1,000 metres thick), the whole being folded into a synclinal structure. The complex is cut by many large intrusions of metadiabase. Clearly there is a close similarity to the Witwatersrand and Blind River, suggesting that the ultimate potentiality of the deposits may be large.

The discovery is not altogether unexpected. As early as 1954 Karelia was considered to be a likely locale for ore deposits of Blind

River type, on the assumption that the granitization represented by the uraninite-bearing Karelian pegmatites could give rise to a disseminated uranium mineralization in the ancient conglomerates there. No news has been forthcoming from the Russian side of the frontier where the occurrence of such mineralization was thought to be the more probable, though recent publications suggest that a great deal of attention is being directed to Precambrian conglomerates throughout the Soviet Union. However, it is most instructive that the absolute age of the sericitic cement in a Jatulian quartz-pebble conglomerate from Russian Karelia has just been reported at 1,870 million years (determined by the potassium-argon method),[3] a value in good agreement with the many determinations on the uraninite and mica from the Karelian pegmatites. It therefore looks as if the new uranium field will yield further evidence in support of an epigenetic, hydrothermal, origin for the banket-type ores.

[1] Anon. *Zeitschr. f. angew. Geol.*, 1960, p. 359.
[2] VÄYRYNEN, H. *Suomen kallioperä sen synty ja geologinen kehitys*. Helsinki, 1954. Russian translation, Moscow, 1959.
[3] KRATTZ, K. O. In *Trudy Laboratorii Geologii Dokembriya*, vol. 9, p. 43. Moscow (Academy of Sciences), 1960.

C. F. DAVIDSON.

Engineering Log

Little is heard in these days of the oilfields of the United Kingdom, yet crude oil production from BP Exploration Company's English fields totalled 41,300 tons in the first half of 1960, as compared with a production of 39,840 tons in the first six months of 1959. The main producing areas are Duke's Wood, Kelham Hills, Bothamsall, and Egmanton (Notts.) and Plungar (Leics.). The company states that development drilling of the new fields at Bothamsall in Nottinghamshire and Gainsborough and Corringham in Lincolnshire is now well advanced. In the Bothamsall field 13 successful producing wells have been completed, production being from horizons in the Lower Coal Measures at a depth of approximately 3,000 ft. The crude oil from these wells is sent by road tanker to Tuxford or Egmanton for water removal, from Tuxford sidings the crude oil being taken by rail to the Pumpherston Refinery in Scotland. In the Gainsborough and Corringham fields five wells have been completed, producing from the Coal Measures at around 4,500 ft., but oil has also been found in several sands down to 5,300 ft. in these fields. At the older Egmanton field equipment for flooding the field has been installed and was commissioned in February last. The company is also continuing its exploratory drilling activities both in the Midlands area and elsewhere in England. Two wells at Apleyhead and South Leverton (Notts.) have recently been completed and tests of some Lower Coal Measures sands revealed encouraging indications of oil, which suggest the possibility of yet two more small fields in this region, although further testing will be necessary. At Kimmeridge, Dorset, where the first significant show of oil in Southern England was discovered by BP Exploration last year, three wells some 2,000 ft. deep and a shallow hole have now been completed, although the information available from the drilling so far is still insufficient to decide whether Kimmeridge will prove to be a commercial field.

* * *

Interest in chemical grouting has been aroused recently by advances reported by several industrial concerns. An article on the Halliburton process appeared in the MAGAZINE for July, while a note in the August issue referred to similar work by the American Cyanamid Company. The work of the last-named concern [1] with its AM-9 has been aimed at preventing several types of water seepage and has been seven years in development and field testing. The chemical, now available in dry white powder form, is applied in a non-viscous solution capable of penetrating any mass which plain water will penetrate. A catalyst is added and the aqueous AM-9 solution is injected or percolated through the soil or rock formation. Time for congealing is controlled, varying from a few seconds to a few hours and depending on the nature of the catalyst added. The solution retains its watery quality until just before the time when it congeals. Once the reaction which produces the viscosity is completed water is excluded from the mass and the soil, sand, or rock particles are bound together with some increase in shear strength. It is believed that soils below the water-table once stabilized by the process retain their stability permanently. Equipment for the application of the chemical,

[1] *Min. World* (San Francisco), June, 1960.

which is recommended to be used by trained grouting engineers, usually consists of two positive-displacement pumps which handle the chemical and catalyst solutions separately. The pumps should have variable-speed controls to enable operators to change solution volumes and control timing and concentration, the solutions being blended at or near the injection point.

* * *

The treaty signed last month by India and Pakistan on the division of the waters of the Indus basin is probably the signal for construction to go ahead on the great irrigation and water conservation projects planned by W.A.P.D.A., the Water and Power Development Authority of West Pakistan. Already, however, considerable effort has been put into preparations before the actual earth moving and engineering begins. The two main schemes involved consist of the system of link canals and barrages which will harness and regulate the waters of the main tributaries of the Indus and the great storage dams at Mangla and Tarbela with their associated reservoirs. In each of these important projects the engineers in charge of design have awarded contracts for air photography and large-scale mapping to the Hunting Survey Group. The Indus link canal scheme, the design and engineering of which will be carried out by Tipton and Kalmbach, Inc., of Denver, will consist of seven canals, approximately 300 ft. wide and totalling nearly 400 miles in length, linking the rivers Indus, Jhelum, Chenab, Ravi, Beas, and Sutlej. Strips of photography, within which the exact route of each canal will be decided, have been flown by Hunting Surveys, Ltd., who are now preparing plans from the air cover at 1/3,600 or 300 ft. to 1 in.; selected areas will have contours at 3-ft. vertical interval. The site of the proposed storage dam at Mangla has been photographed and mapped for Messrs. Binnie, Deacon, and Gourlay, the consulting engineers, at 1/2,400 scale with 10-ft. contours and at the same time maps for the Tarbela dam site to the same scale were made by Hunting's Canadian Division. In addition to the engineering contracts mentioned W.A.P.D.A. has called for an investigation into the management of the catchment area serving the vast reservoir to be created by the Mangla dam. Photography of 2,780 sq. miles has been taken as the first step in an extensive conservation study. A two-year programme of investigation in the field is now in progress during which a Hunting team, headed by an ecologist, will analyse causes and extent of erosion and will map both present land use and land capability.

* * *

Use of coatings based on zinc dust for maintenance instead of a galvanized finish has increased in recent years, some of these coatings being based on epoxy resins, others on rubbers, and still others on inorganic binders of various types. It is strongly recommended for most of these finishes that mill-scale be removed from the underlying steel before application of the coating and one company in the United Kingdom markets its own pre-treatment mill-scale remover. However, 12 months after the introduction of a silicone-based zinc coating in the United States the Carboline Company there are re-affirming their opinion of the needlessness of mill-scale removal when using this company's product. In a recent statement it is reported that experiments have been made on the outside of tanks and structural steel with wire-brush preparation instead of the conventional sand-blasting. Channels of steel on which the mill-scale was half-rusted off were wire-brushed and dressed with the company's Carbo Zinc 11 while others were prepared with a good vinyl primer. On the vinyl samples the mill-scale popped off, whereas the Carbo Zinc 11 samples remained good for two years in a mild industrial atmosphere. The Carbo Zinc 11 product, a zinc-filled inorganic substance with filler added before application, is normally used as a single-coat protection or as a primer in temperature ranges from *minus* 80° to 750° F. and can be cured where hardening is desired within two hours. It resists most chemicals except acids, alkalis, or salts with pH greater than 9·0 or lower than 5·5.

* * *

Future motorists, forsaking the monotonous greys and blacks used for present-day highway surfaces, may use coloured roads instead. Thermoplastic materials mixed from petroleum products and aggregate such as rock or sand can be made in any colour and when rolled out may be applied as inch-thick surfacing material on paving already laid. Traffic theorists expect that colour will facilitate the process of following the road. Curbs, defining road boundaries, junctions,

intersections, and danger spots will also be coloured and are expected to contribute to road safety. Newly-developed materials employing versatile polypropylene, polyethylene, and polyisobutylene are currently under test in Linden, New Jersey, at the Esso Research and Engineering Company's centre. The materials are almost ready for full-scale testing on aerodrome landing fields and busy roads. Resistance to oil is a useful attribute of the new plastic material. During development the paving materials were subjected to the Marshall stability test, in which core-like samples are placed in a machine at a temperature of 140° F. and pressure is exerted. For light use 500 lb. pressure is used in testing; for heavy use, 750 lb.; for very heavy use, 1,000 lb., and for aerodrome use, 1,800 lb. A 1,000-lb. rating material accepts a load of 100 lb. to 120 lb. per sq. in. and a 20-ton truck exerts some 70 lb. p.s.i. New materials, Esso say, have reached stabilities of two to three times the Marshall standards.

* * *

The United States Bureau of Mines Report of Investigations 5632 covers work carried out on "Controlling Mine Fires with High-Expansion Foam." The technique, developed originally in England,[1] involves the use of chemicals to create a foam which is pushed toward the site of the fire by the mine's ventilating current. The Bureau's studies at its experimental coal mine near Pittsburgh have covered various kinds of foam-making chemicals and foam-making equipment as well as different types of fires. The Report tells of foam attacks on 16 fires set in the mine—14 with coal, one with wood, and one with oil as a fuel. Thirteen of the fires were brought under control, including those involving wood and oil, the three coal fires not controlled being subjected to foam purposely low in water content. It is suggested that the foam must contain at least $1\frac{1}{2}$ oz. of water per cu. ft. of foam to be effective. Some of the fires were extinguished outright, but the studies revealed that in many instances the foam's chief effect was a cooling influence that permitted experimenters to enter the fire zone and make a direct and final attack with water or other extinguishing agent or load the hot material into cars for removal from the mine, although the foam has a blanketing effect which reduces oxygen and prevents air circulation. As a result of its experiments to date the Bureau continues to recommend that rock dust (powdered limestone) or other "approved and readily available extinguishing agents" be tried first on mine fires because they can be used more readily. Foam-making equipment, which requires time to set up, may prove more advantageous where heat, roof falls, and smoke prevent direct approach with conventional fire-fighting methods and equipment. "The effectiveness of foam in controlling a deep-seated fire of considerable extent has yet to be proved by actual trials in a mine."

* * *

Eight years ago a major deposit of natural gas was located at Lacq, near Pau, in France. It contains 280 milliard cu. m. of gas at a pressure of 670 kg./cm.^{2} and 140° C. and is so rich in sulphuretted hydrogen that it corroded ordinary steel tubing in a few hours. Exploitation has required the use of specially resistant alloys, elaborate desulphurization, and finally storage of the processed gas in a deep stratum of sealed-off porous rock some 35 miles distant. Production of 98% pure methane has now reached 4 milliards of cu. m. annually. In addition 130,000 tons of propane and butane and twice that tonnage of petrol are being yielded. At this rate of exploitation a 30-year life is assured for this deposit. Already 1,000 miles of pipeline connect Lacq with Toulouse, Bordeaux, Nantes, Paris, Besançon, and Lyons, but extensions are in hand which may soon link the system with the Sahara and other gas grids. Some 40% of the Lacq output is reserved for use in south-west France and big consuming industries are moving in. Construction in hand includes an electric power station, an aluminium plant, ammonia, acetylene, methanol, plastics, and fertilizers in addition to the production of 1,400,000 tons of sulphur annually from the desulphurizing process. Three thousand dwellings have so far arisen in a new town, Mourenx-la-Neuve, and this scheme has been artistically blended into a naturally attractive scenic zone.

* * *

Solaris, a robot for seeking and retrieving objects lost in the ocean at depths down to 2,000 ft., is being developed by Vitro Laboratories, Silver Spring, Maryland. It will be used by the Naval Torpedo Station at Keyport, Washington, to recover torpedoes from test range there and it is thought the robot might also be used to recover exhausted

[1] THE MINING MAGAZINE, Nov., 1955, p. 260.

solid-fuel rocket boosters. Solaris moves by means of propellers and it is equipped with a TV eye and powerful pincers. When the eye spots an object on the ocean bed an image of the object sighted is flashed on a monitoring screen on board the control ship at the surface. Operators on board the control ship then guide the robot to the object and clamp it in the pincers. The Solaris weighs 500 lb. and at 1,600 ft. down it can patrol a wide area at one anchoring of the control ship. The TV camera can normally see 15 ft. to 25 ft. and under ideal conditions will see a 1-in. diameter cable at a distance of 50 ft. It can retrieve any object weighing 7,500 lb. or less in the water. Under bad visibility conditions in turbid water a sonar system assists the TV camera in locating objects so that the work can continue.

News Letters

BRITISH COLUMBIA

September 12.

Company Affairs.—The *British Columbia Gazette* of August 21, 1960, lists the following companies as having been "struck from the register and dissolved":—

B.C.-Cal. Oil and Gas, Ltd., Blue Jay Mining Syndicate, Ltd., Border Development Co., Ltd., Colonial Exploration, Ltd., Consolidated Helicopters, Ltd., Consolidated Pipelines Investment Corporation, Ltd., Copper King Mines, Ltd., Cordillera Exploration, Ltd., Douglas Mining and Development Corporation, Ltd., Father-Lake Development, Ltd., Fenchurch Mining Co., Ltd., Foster Ledge Gold Mines, Ltd., Glen Mountain Mines, Ltd., Grosvenor Gold Mines, Ltd., Minerals Consolidated, Ltd., Pac-Coast Petroleum, Ltd., Spanish Mountain Exploration Co., Ltd., Vancouver Helicopter, Ltd., Ymir Gold Mines, Ltd., and Zenda Exploration Co., Ltd.

Vancouver Island.—Qualicum Mines, Ltd., has been formed to acquire and proceed with the development of the properties of the Mt. Washington Copper Co., Ltd. Noranda Exploration, which has provided the major funds and directed the exploration to date, has the right to name four directors and Mt. Washington has already designated its president and vice-president to serve on the Qualicum board. When a million dollars have been expended on development, with 70% provided by Noranda and the balance by Mt. Washington, the former will be entitled to a 52% interest in the operating company and Mt. Washington to the remaining 48%.

An extraordinary meeting of shareholders of Cowichan Copper late in August approved the proposal of directors that the company issue 500,000 shares to acquire control of Nadira Mines, Ltd., Avallin Mines, Ltd., Caycuse Copper Co., Ltd., and Cellardor Mines, Ltd. Available ore from the Nadira and Cellardor properties will enable Cowichan to increase the scale of development in its own Blue Grouse property, at the same time maintaining mill operation at the current 300-ton-per-day rate.

Allied Mining Services, Ltd., is to construct a 5-ton mill to treat the selective ore mined under lease in the Tofino gold mine.

New Westminster.—Development work is to be resumed by Canam Copper as a result of a firm commitment and underwriting guaranteeing sufficient funds to drive a 1,200-ft. extension to the 15-level tunnel of its mine on the Hope–Princeton highway, east of Hope.

Similkameen.—The Granby Mining Co. suffered a loss of $151,961 in the first six months of 1960, the income from mining and miscellaneous sources being $852,832. Production expense was $711,418, exploration, $20,166, and administration and other expense $100,590, leaving a profit before write-offs of $20,658. The provision for depreciation and depletion was $172,619. The subsidiary, Phoenix Copper, earned an operating profit of $95,110 before depreciation and depletion, after the treatment of 166,967 tons of ore.

Greenwood.—Continental Consolidated Mines, which is developing a copper property adjoining that of Phoenix Copper, has taken an interest in the Ephus Syndicate, which is seeking to recover gold and platinum from the known Granite Creek deposits, near Coalmont. As a result of the machinery and equipment, as well as capital, supplied by Continental, the Ephus Syndicate is already advanced 50 ft. in the course of a projected 350-ft. underground drive in hardrock to reach a point below the projected position of the rich gravel. Box-chutes are to be raised to bedrock and the fine gravel withdrawn through the entry.

The Niagara Mining and Development Corporation, a new British Columbia company, has acquired a number of prospects in the Greenwood area and plans immediate work on three—the Crow and Raven groups, adjoining the Consolidated Woodgreen mine, and the Bruce, 3 miles west of Midway. The company is capitalized at 5,000,000 shares of no par value of which 900,000 shares have been issued for properties. A public offering is now being made to finance the proposed work.

Cariboo.—A first-mortgage bond issue of the Cariboo Gold Quartz Mining Co., Ltd., has been over-subscribed. The $200,000 sought was to provide funds for the extension of two underground entries into the Burnett fault zone of the company's mine, previously opened by the 3,000-ft. drive only. Development proved the section to contain extensive replacement-ore deposition of a very high-grade assay and the company is now to extend the 3,125-ft. level drive a projected length of 900 ft. to reach the upward projection of rich ore in the "64" ore-shoot and other bodies, as indicated by diamond drilling. The 2,850-ft. level, 150 ft. below the present development, is to be extended into and beyond the Burnett fault to reach ore-bodies which apparently "top" in the fault. These bodies are to the west of the fault and as projected will extend almost to the position of the Mosquito fault zone, which will be the next objective of underground exploration. Of coincidental circumstance has been the recent discovery of exceptionally rich placer gold in the bed of Mosquito Creek, some 1,700 ft. above the objective of the underground approach. The Mosquito fault is clearly exposed in the placer pit and a 20-in. occurrence of replacement ore, 12 ft. to 15 ft. in length, has yielded two representative samples assaying 0·60 oz. and 1·20 oz. of gold per ton. Free-gold

recovery made in the hydraulic operation included asignificant quantity of coarse, rough, fresh gold that appeared to have travelled not more than 100 yd. at most. It included a 3·6-oz. nugget with quartz and galena attached. The company's consulting engineer, Mr. E. E. Mason, concludes that the discovery in the Mosquito fault zone, in the immediate vicinity of the Burnett fault workings, enlarges possibilities of the new area two-fold. The company's gold production for the first half of August exceeded 1,000 oz. of gold and was the best in the past 16 months.

Golden.—During the fiscal year ended May 31, 1960, Sheep Creek Mines, Ltd., produced 7,136 tons of lead concentrate assaying 65·34% lead and 13,000 tons of zinc concentrate assaying 57·20% zinc from 188,681 tons of ore milled. The following metals were recovered and sold in the quantities listed: Silver, 211,092 oz.; lead, 9,325,521 lb.; zinc, 14,875,237 lb.; cadmium, 49,538 lb., and copper, 181,877 lb. The company also produced 9,407 tons of barite, which was all the market would absorb. The net income from the sale of concentrates was $1,483,465 and from barite sales $70,451; other income amounted to $25,765. Operating expense included $927,937 for mining and milling, $25,859 for loss on camp and cookhouse operation, and $84,042 for administration and general expense, including directors' fees. After provision of $59,121 for depreciation, $83,043 for amortization of development and pre-production expense, and $2,079 for outside exploration, the net profit for the year was $397,600. At the year end current assets were carried at $1,254,619, against current liabilities of $185,366. Of the authorized capital of 3,500,000 shares of a par value of 50 cents each 1,875,000 shares were issued. Ore reserves in the Mineral King mine increased by 99,982 tons and at May 31, 1960, were estimated at 415,834 tons assaying 2·17% lead and 5·71% zinc. The Paradise mine contained reserves of 40,850 tons averaging 4·5 oz. silver per ton with 5·0% lead and 9·2% zinc. In its 26 years of existence the company has paid dividends aggregating $2·10 per share to shareholders who originally paid 30 cents per share for their stock.

Yukon.—The exploration being conducted by Klondike Lode Gold Mines, Ltd., in search for the lode responsible for the prolific placer production obtained in Eldorado and Bonanza Creeks has been materially assisted by the sluicing operations of Ballarat Mines, Ltd., in the bed of Eldorado Creek. This work has clearly outlined a fault zone in the east bank of the creek. The Klondike company has gouged five long and deep bulldozer cuts into the side of Lone Star Mountain above the position of the fault zone in the creek bank, has conducted a systematic programme of soil sampling which has yielded strong indication of gold content, and has cut through to bedrock in four places, in all of which free gold has been visibly present. A 400-ft. inclined cut found a 20-ft. band of solid rock containing numerous stringers. Dr. F. C. Buckland, the company president, states the intervening zone material carries gold values as well as the quartz and the full width will qualify as ore. Five big cuts have been made on the Bonanza Creek side of Lone Star Mountain, but the prevalence of permafrost has as yet retarded penetration to bedrock.

EASTERN CANADA

September 27.

Ontario Gold Production.—The output of the gold mines of Ontario for June included 223,833 oz. of gold and 49,765 oz. of silver, valued at $7,756,490, from 791,488 tons of ore milled. In July 779,426 tons yielded 222,179 oz. of gold and 37,002 oz. of silver, worth $7,664,968.

The Department of Mines' June "Gold Bulletin" says that for the first six months of 1960 the Province's 30 producing gold mines reported milling 4,699,047 tons of ore, from which was produced 1,346,573 oz. of gold and 224,758 oz. of silver, valued at $45,590,865. For the same period in 1959 the same mines reported milling 4,671,480 tons of ore, producing 1,331,794 oz. of gold, and 194,346 oz. of silver, worth $45,237,859. During June there was an average of 11,316 wage earners and the average grade of ore was $9·80.

Canadian Uranium Industry.—During 1959 the value of Canada's uranium production rose to $333,000,000—higher than that of any other metal produced in the Dominion. The year's uranium-oxide shipments totalled 15,909 short tons, as compared with 13,537 tons in 1958. During 1959 there was 23 mines and 19 treatment plants at work in Canada, but by December 31 last there were only 20 mines and 17 mills operating. The plants treated about 14,000,000 short tons of ore averaging 0·12% U_3O_8. The Department of Mines and Technical Surveys in Ottawa gives the reserves of uranium ore in Canada at November 1 last as 308,500,000 tons averaging 0·12% U_3O_8.

Aeromagnetic Survey Maps.—The Ontario Department of Mines last month announced the release of ten aeromagnetic maps covering part of the District of Kenora. Numbered 870 to 879, inclusive, the maps are on a scale of 1 in. to the mile.

Porcupine.—In the first six months of the currant year Pamour Porcupine Mines milled 324,550 tons of ore and recovered gold valued at $1,086,700. In the same period Aunor Gold Mines milled 134,131 tons for an output worth $1,498,600.

Iron Ore.—Shipments of ore from Canadian iron mines totalled 2,700,000 tons, as compared with 2,200,000 tons in May, 1959. In the five-month period to May 31 total shipments were 3,200,000 tons.

Quebec.—It is reported that the Continental Titanium Corporation plans a small-scale plant for the production of titanium dioxide from Quebec ores by a new continuous leaching process. The plant is to be situated in the Baie St. Paul district, east of Quebec City. Initial production is anticipated by mid-1961 and would be about ten tons per day of almost pure titanium oxide.

AUSTRALIA

September 20.

Raw Materials.—According to a report issued by the Bureau of Mineral Resources it is expected that there will be a satisfactory demand for Australian raw materials during the rest of 1960. In 1959 activity in the industry was well maintained. Lead and zinc production was lower and sales were substantially reduced, while the output of tungsten concentrates was the lowest for many years. Copper production continued to expand during 1959,

reaching record levels, and asbestos, iron ore, and zircon were at a peak, and tin production increased moderately. There was a rapid increase in production of Victorian brown coal, but production of black coal remained at about the same level as in 1958. This year there has been a marked increase in the production of New South Wales black coal and a substantial export trade is expected by the end of the year, with good prospect of continuance.

A pressing problem in the development of the coal export trade is that of modernization of harbour and loading facilities at the coal ports of Sydney, Newcastle, and Port Kembla. A large measure of future coal trade is expected to be with Japan and the Japanese are chartering coal carriers of 35,000 to 45,000 tons capacity. The use of these vessels makes possible a substantial reduction in freight charges and if they cannot be expeditiously loaded and turn-round time reduced a large part of this potential trade may be lost to Australia. The situation calls for prompt and substantial Government co-operation in providing adequate port facilities. At Port Kembla very good progress has been made in the inner harbour works undertaken to assist the rapidly-expanding steel industry; the New South Wales South Coast coal industry will obtain substantial assistance for its export trade by the completion of this important work.

It is expected that the final survey of the mineral industry position for 1959 will show some increase on the £A202,000,000 total of 1958, the main increase being in the value of the copper products. A disturbing feature is the increase in imports of refined tin—an importation expected to increase with the growing industrial demand. It is a strong argument for some form of assistance to domestic tin mining, which could be in the form of assisted prospecting, development of deposits, and aid to operating companies by taxation remissions or variations. Tin mining has never been popular in Australia and a Government-assisted policy to remove this old prejudice and popularize the exploration for tin deposits and ease the difficulties facing normal operations should achieve useful results.

Although there has been a marked improvement in industrial relations on the coalfields the miners' union has not yet fully realized that the future of the industry can still be precarious. There is an insiduous demand growing for a 35-hour week underground which would seriously threaten the future and there has been a recent increase in the number of strikes which must inevitably disorganize overseas contracts and lose trade. Figures for 32 weeks of 1960 show a coal loss of 340,540 tons through strikes.

Oil Exploration.—The Commonwealth Government is giving substantial aid to oil prospecting by way of subsidies and valuable assistance has been given to exploration and drilling companies in taxation concessions. Under the Petroleum Search Act, 1959, ten applications for subsidies had been approved at July 19 last. Since then five more applications have been approved involving a total of £A312,072. Two are for drilling operations, two for seismic surveys, and one for an aeromagnetic survey.

Australia continues to be an interesting field for oil exploration to overseas interests. Recent announcements are that the Texas American Oil Corporation intends to start an exploratory programme on two concessions of 3,200,000 acres each in New South Wales, one in the Great Artesian Basin and the second in the Murray Valley Basin in the south of the State. The company also has applications pending for 6,000,000-acre concessions in the Georgina Basin in the Northern Territory. The applications are based on geological reports made by recognized engineering and geological authorities, including the Petroleum Institute of France.

The Hunt Oil Company of Texas and the Placid Oil Company of Louisiana are seeking permits to explore for oil in the north and central parts of Western Australia. Permits to explore east and south-east of Wiluna have been granted to Textralian Oil Pty., Ltd., and these permits are being transferred to Hunt Oil and Placid Oil.

New Zealand.—Practically speaking, the metalliferous mining industry of New Zealand is represented by two bucket-dredging operations which are both profitable and have a number of years' life; there is nothing, however, to replace them when their ground is worked out. There have been recent reports of investigations into the treatment of the auriferous tailings from the old Waihi mine, but little is known as to the progress of the test work. There is also a movement directed to the utilization of the large tonnages of titaniferous iron sand and the probable establishment of an iron and steel industry based on this raw material, but while the raw material is there little information has as yet been made available on the metallurgical approach to the project, which represents the major problem.

The coal industry of the Dominion also appears to be in a rather weak position, despite Japanese interest in obtaining supplies. Hope has been expressed for the establishment of an aluminium industry using Weipa, North Queensland bauxite, and hydro-electric power from Lakes Manapouri-Te Arnau, while a new project being studied by the Government is the use of the South Island limestone deposit for the manufacture of calcium carbide. It is stated that the Government will welcome any private group interested in this proposed industry and is prepared to grant power concessions.

Oil drilling has given some encouraging indications but so far there has been no development of commercial importance. It is also believed that progress is being made with the establishment of a scrap steel industry which could be a considerable help in meeting New Zealand requirements. Results from active prospecting of uranium occurrences are stated to be disappointing.

Broken Hill Proprietary.—The operations of Broken Hill Proprietary are the major feature of Australian mining, headed by the profit of £A9,400,000 for the year ended May 31, 1960, after providing £A5,500,000 for depreciation. On the operating side a very interesting development is the decision to install L.D. steel-making plant, which will replace some of the open-hearth furnaces. This oxygen process is to be a feature in the steelworks being constructed at Whyalla, South Australia, although oxygen-blowing in the open-hearth furnaces has been developed successfully at Port Kembla. Two L.D. furnaces are to be installed at the Whyalla plant, the estimated cost when completed being £A41,000,000. To meet requirements the pipeline from the Murray River must be duplicated, which will be a substantial piece of work. Housing as well as primary, secondary, and tertiary schools must be provided, in which works the South Australian Government will

co-operate. At Newcastle a new four-stand high-speed rod-mill will replace the present two-stand mill and a large sinter plant, estimated to cost £A9,600,000, is now nearing completion. Despite these great constructional expansions the Australian demand for steel is so great that requirements cannot at present be met.

Iron Ore.—Investigation of the iron-ore resources of Western Australia continues to be an important part of the State's mining activities. Diamond drilling by the Government on the Bungalbin-Walton occurrence in the Yilgarn mineral field is reported to have indicated 43,415,000 tons of inferred iron ore in four deposits all above the level of the plain, the grade of the four deposits being stated to average 60% Fe. The deposits are north of those at Koolyanobbing, which have been prominent in discussion for some time and extend north from Boorabbin, on the Perth–Kalgoorlie railway. A geological survey by the Department of Mines has said that the occurrences do not contain any high percentage of elements detrimental to the utilization of iron from the ores. The view is held that in conjunction with the high-grade deposits in the adjacent Koolyanobbing district the occurrences in the Bungalbin–Walton locality could establish an iron-ore centre in this part of the State.

In addition to the four high-grade occurrences there is a very large tonnage of iron-bearing jaspilite in an extensive zone in the belt. This jaspilite zone is regarded as having potential economic value. Its prospective value will depend upon the investigations being carried out by Broken Hill Proprietary into the economics of turning to commercial use the great occurrences of jaspilite in that company's leases in the Middleback Ranges of South Australia.

Kalgoorlie Mines.—Great Boulder Gold Mines, Ltd., in the year to June 30, 1960, made a net profit of £A274,891, the ore treated amounting to 506,546 tons, from which 124,021 oz. of fine gold were recovered. The head value of ore milled was 5·37 dwt. per ton and ore reserves are estimated at 2,027,400 tons with an average grade of 5·62 dwt. Development footage was 16,473 ft. in the year just closed and the diamond-drilling footage 9,170 ft.

Recent exploratory work by North Kalgurli (1912) has been very encouraging. The ground between the North Kalgurli workings and the Croesus mine is virgin and the gap between the two mines, 2,500 ft., is being explored. North Kalgurli re-opened the Croesus mine in 1956 after it had been closed down for 14 years. At the present time 6,000 tons of ore per month are being won from this section of the property, the average grade of the ore mined being 5·0 dwt. per ton. Driving between the two mines is at 1,000 ft. depth and passes under the old Eclipse workings which have a depth of approximately 600 ft. At the time the Eclipse was worked several other shafts had been sunk in the area but results were disappointing at about 300 ft. The south drive from Croesus has been extended for 1,000 ft. in the last year, but a considerable time must elapse before connexion is made to the main North Kalgurli shaft.

Reports from Gold Mines of Kalgoorlie have recently given news of some spectacular values. Driving at No. 12 level has exposed a continuous length of ore with an average value of 26·5 dwt. per ton over 46 in. and an internal shaft is being sunk from No. 11 level to open up other reefs at lower horizons. There have also been favourable developments in others of the company's group of mines. Important additions to reserves have been made at Paringa where ore with an assay value of up to 11·5 dwt. has been disclosed by diamond drilling. Two other lodes in the eastern group have also developed well and in the western group development is being pushed ahead at a depth of 500 ft. below the nearest operating level. In this western development individual assays have been as high as 54 dwt. gold. Again good lengths of ore have been exposed in the development of the Perseverance and El Oro lodes.

FAR EAST

September 19.

Malaya's Tin Outlook.—Mr. D. R. Mitchell, chairman of Kuala Kampar Tin Fields, Ltd., told the general meeting over which he presided in Kuala Lumpur on September 7 that the tin outlook was "much better." The International Tin Council's announcement that export control would be lifted on October 1 would enable the Malayan industry to prepare to restore its productive capacity to a full-scale basis, pending the orderly disposal of accumulated minehead stocks.

Mr. Mitchell also presided over several other meetings, at that of Kampong Lanjut stating that, in view of the lifting of control, preparations were now in hand for restarting the Wardieburn dredge. Berjuntai shareholders were told they would receive one free bonus share for each share held—subject to sanction being obtained from shareholders at a meeting to be called soon. Mr. Mitchell said it was time to bring the issued capital more into line with value of the assets, which would include four modern dredges reconstructed and put on the Batang Berjuntai property, while the former Rawang No. 3 dredge had a useful life in the Sungei Sembah area. He added it was not implied that future earnings would be doubled, but the potential output of Berjuntai's five dredges was far greater than before the amalgamation with Rawang.

Following the decision to lift export controls Mr. Chong Khoon Lin, president of the All-Malaya Chinese Miners' Association, expressed a generally-shared belief when he said: "The lifting of the control is a healthy sign. The supply and demand have come to a level." Meanwhile latest available figures show that by the end of July only 14 fewer tin mines were functioning in Malaya than in December, 1957, when tin restriction began. The actual number of mines was 583, or 16 more than in June, but the labour force at 27,624 was 8,961 fewer than before restriction started.

Iron Ore.—As a result of the hunt for iron ore in reputedly rich land around the Kedah Peak area in Malaya one of the most valuable sections is reported to have been found at Sungei Toh Pawang, an estate belonging to the Kulim Rubber Plantations group. The estate recently granted a Chinese firm the right to prospect over 500 acres and operations were started on several fields of the estate, the ore output being said to average 7,500 tons a month, a yield expected to increase sharply. Under the agreement the prospecting company pays the estate a tribute for every ton of ore found.

Iron-ore mining in Malaya set up a record production total of 2,551,140 tons for the first six months of this year. The ore came from 15 mines

scattered in five states, seven of them in Perak, three each in Johore and Kedah, and one each in Kelantan and Trengganu. At the end of last year there were 11 mines in production and the year's total output was 3,760,684 tons. It seems that this year's total may exceed 5,000,000 tons.

The Sultan of Perak heads the list of members of Perak royalty who share in property of the iron-ore industry. This was shown in a Government reply made in the State Legislative Assembly in answer to questions. Another reply said royalties from iron mining last year totalled (Malayan) $2,160,025 ; for the first half of this year the total was $1,687,166. The land leased in the Sultan's name consisted of 22 acres, while Raja Musa ibni Sultan Abdul Aziz controlled 70 acres and Raja Haji Kamaralzaman bin Raja Mansor, in partnership with Mr. Yeoh Cheang Lee, had claim to 18 acres.

North Borneo.—A mine capable of producing some 9,000 tons of coal a month is to be opened in the Sebatik region, near Tawau. Six miles of railway to transport the coal from the area are being built and are due to be completed soon. Mr. Wang Yaw Tung, manager of Hai-Hong Trading Co., Ltd., the firm holding the coal prospecting permit, said that during the first months after the opening of the mine the company would get about 9,000 tons of first-quality coal each month.

Pakistan.—The Pakistan Industrial Development Corporation has completed a survey of the iron-ore deposits in the Chitral area at a cost of Rs. 197,000. The prospects of getting good-quality iron-ore from the area are considered bright.

Another asbestos cement plant is proposed to be set up in Pakistan to increase the production of asbestos sheets for building purposes. A team of Belgian experts has been studying the possibility and is due to report soon.

The Pakistan Government has finalized a scheme to raise the production of chromite from 18,000 tons to 50,000 tons a year by 1964. The entire quantity of chromite produced in the country is exported and to boost production the Government has made available licences for the import of heavy machinery and equipment. Meanwhile the Kharian and Raz Koh mine areas, where high-grade chromite has been discovered in commercial quantity, are likely to be developed shortly and a scheme for beneficiating poor-quality mineral is being pursued.

SOUTHERN AFRICA

September 29.

Railways.—In a recent address to the National Development Foundation the general manager of South African Railways commented that the railways can claim to operate as an industry in producing transport and in the field of commerce as sellers of that product. In terms of the Act of Union the railways are obliged to meet the country's requirements as a whole and, with certain reservations, at cost ; they are not permited under the Act to become a profit-making undertaking. The Act itself states that " the railways, ports, and harbours of the Union shall be administered on business principles, due regard being had to the agricultural and industrial development within the Union and promotion, by means of cheap transport, of the settlement of an agricultural and industrial population in the inland portions of all the provinces of the Union. So far as may be (possible) the total earnings shall be not more than are sufficient to meet the necessary outlays for working, maintenance, betterment, depreciation, and the payment of interest due on capital . . ."

At a time when grave doubts were being expressed about the future of railways, when certain economists were forecasting the end of the railway age, when railways were being criticized as having become outmoded and too inflexible relative to modern requirements the South African Railways took one of the major decisions of its history shortly after the end of the last war. A nation-wide programme of expansion was prepared and initiated involving since 1946 the expenditure of £519,000,000 on capital account. At various times the programme experienced acute difficulties in procuring the necessary materials and equipment and finding and recruiting technical and other staff. New lines were built either to relieve pressure on existing lines or to meet new demands as in the case of the extension of the producing goldfields into the Free State. The more important main lines have been doubled—in the case of the Natal line from 25,000 to 50,000 tons daily at a cost of £24,000,000. Electrification was extended where traffic pressure was unduly heavy and diesel locos have been added to the establishment. Over the 14 years reviewed, tractive power has been increased by about 45% and merchandise carrying-capacity by more than 108%. In short the railway has been extended to every corner of the country, supplemented, where necessary, by road services. In the case of mining—an industry which has ever been ready to acknowledge the role of the railways in their enterprise and has from time to time volunteered to guarantee particular lines against working losses—a real glimpse of the scope of the railway services provided is given.

With 1939–40 figures in brackets, the 1959–60 returns included 1,175,808 (1,017,482) tons of manganese ore carried as well as 3,357,744 tons of iron ore (1,227,693), 740,883 (429,373) tons of chromite, and 20,646,275 (16,134,974) tons of coal. All South African electric-power stations are based on coal fuel and the rail rate on coal has to be kept low in order to promote electric-power generation at the lowest possible cost. In the 1958–59 year the railways carried 18,957,069 tons of coal at an earning of £16,648,000,000 but at a cost of £16,800,000. Included in the programme of expansion since 1946 were the extension of the line from Oogies to Broodsnyersplaas in the Witbank coalfield of the Eastern Transvaal, construction of the line from Hennenman to Odendaalsrus and Allanridge in the Free State goldfield, and of the new line to Siwhen in the Postmasburg manganese-iron-ore fields of the Northern Cape, which line is now being extended to Hotazel.

The railways are the largest single buyer of manufactured products. South African producers participated in the amount of £100,000,000 in five years to 1959. It has promoted the local fabrication of goods wagons and rolling stock and suburban electric passenger stock and electrical equipment. Direct imports on railway account amounted to £29,600,000 in the same period. Not the least of the railways services is the provision of cheap transport for workers, especially the urban Bantu workers, and to and from the mining centres of the Southern Transvaal and Free State.

Engineering Merger.—Effective from the end of the year is an agreement recently announced between Babcock and Wilcox, Ltd., and the Vanderbijl Engineering Corporation, Ltd. The latter is to acquire and operate the former's works at Vereeniging, as well as a 25% interest in a new South African venture to be established by the former, which in turn and *inter alia* will acquire 400,000 Vanderbijl Engineering shares. Representatives of both the Vanderbijl Engineering and the new Babcock and Wilcox company will be appointed to both boards of directors. The new company will continue to administer sales, contracting, erection and servicing, and engineering design of the Babcock and Wilcox products.

Trade Figures.—With imports and exports both advancing over the first eight months of 1960 to £382,700,000 and £296,200,000, respectively, from the corresponding 1959 figures of £336,700,000 and £270,000,000, the adverse trade balance in the 1960 period deteriorated to £86,500,000 from £66,700,000 in 1959. Both debit amounts were more than adequately covered by gold output and sales. The favourable overall balance, however, has been more than offset by the drain on reserves caused by the outflow of capital funds. By the end of August, 1960, these reserves had declined to £98,607,000 from £151,886,000 at the end of December, 1959. While the decline has been evident in both exchange and gold holdings it has been the more marked in the former.

Dr. Van Eck, chairman of the State-sponsored Industrial Development Corporation, said recently that while South Africa experienced no difficulty in marketing its gold and diamonds it should look to its local markets for disposing of its industrial production. Over the next 10 or 20 years the country would have to look to itself and rely on its own resources for raising the standard of living. In comparison with its national income the country's imports are still higher than those of almost every other country in the world in an economy which had advanced the value of its industrial production to nearly £2,000,000,000.

Dr. C. S. Richards, Professor and Head of the Department of Commerce, Witwatersrand University, Johannesburg, affirms that the malaise which has overtaken the South African economy in the past two years is due largely to the withholding and/or the actual withdrawal of those fertilizing streams of overseas risk capital which has opened up new activities, embarked on new ventures, and installed new plants and factories. South Africa will need more, much more not less, external capital than in the past to finance the large expansion postulated in Government plans to provide continuously higher standards for all multiracial inhabitants.

Transvaal.—Rustenberg Platinum Mines reports that in the year ended August 31 last it received £3,462,000 as net revenue from metal sales, as compared with £2,074,642 in the previous year, of which dividends absorbed respectively £2,160,000 and £1,140,000. The 1959–60 revenue improvement resulted partly from the increased average platinum price and partly from increased sales of by-product metal output consequential on the higher scale of mine operations. With platinum marketing in the second half of the year becoming relatively inactive overall sales failed to reach expected levels but were maintained at about the previous year's levels. Reduced sales to the United States and a recession following the brisk market activity early in 1960 were the main factors in the adverse second half-year's results which abnormally extended the usual seasonal mid-year easing. A recovery may now be expected. Operations were expanded during the year to build up stocks to more suitable levels and included the commissioning for the first time since completion in 1957 of the new treatment plant at the Union section. Circumstances will determine the adjustment of operations to the needs of the moment and between the various sections of the mine and plants.

In the southern-central section of its lease area of 4,225 claims Leslie Gold Mines has obtained values of 80·9 dwt. over 5·6 in. at a depth of 1,476 ft. below collar in the ventilation component of its twin-shaft system. Water-bearing fissures have been encountered, as expected, during shaft sinking. The eventual milling programme aims at raising the rate from 65,000 tons a month which will be reached shortly after the start of milling to 90,000 to 110,000 tons and, ultimately, to 150,000 to 180,000 tons a month. In the last stage of advancing the milling rate a second large-capacity shaft system will be sunk in the western section of the lease area.

At Western Deep Levels, which recently obtained further disclosures of values on the Ventersdorp Contact Reef, both shaft systems will have a total hoisting capacity of about 300,000 tons a month. The initial milling rate, expected to be achieved by late 1962 will be 80,000 to 96,000 tons a month of Ventersdorp Contact Reef; subsequently to be raised to 120,000 to 144,000 tons and finally to 200,000 to 240,000 tons a month, in which stages both Ventersdorp Contact and Carbon Leader Reef will be milled. The average mill grade in the latter stages should at least be about 10 to 14 dwt. a ton. A reasonable expectation at this stage is that the mill tonnage will be drawn from the Ventersdorp Contact and Carbon Leader Reefs in the ratio of about two to one.

Treatment Plants.—Further advances in automation and mechanization on the gold mines, this time in the gold plants, has been mentioned recently. It is understood that tests have been under way for some time on the application of the " Stellar " filter unit to the clarification of pregnant cyanide solution before precipitation and to the filtering off of the precipitate of zinc-lead-gold-silver from the barren solution. In the latter operation, the tailings values of the barren solution have been stated to have been reduced by about 20%. Other benefits lie in the fully automatic operation and the almost complete elimination of manual handling in the final processes of gold metallurgy in the South African fields. Operated on a time/pressure cycle the phases of filter bed deposition (using kieselguhr), filtering off the suspended solids, dropping the filter cake, and discharging it for transfer to the following stages of treatment, are automatically effected and controlled. Sampling of the barren effluent or the filtrate is effected by an opacity meter, which scans the flows and is capable of determining turbidity of the order of one part per million parts. Any excess turbidity above a set maximum brings in a cut-out link which automatically shuts down the affected unit. A number of mines in the Transvaal and Free State are understood to have installed or are installing these filter units, either for clarifying the pregnant solution or filtering off the precipitated metals or

both. It is difficult to estimate the increase in recovery that will be effected or could be effected. If all the gold of the industry were recovered through the filtering method described, and operational results measured up to the test runs, the increased recovery could be of the order of 140,000 to 280,000 gold ounces a year.

African Metals Corporation.—In its 1959–60 year, which saw the completion of a major programme of expansion, there was an all-round advance in production and sales by the African Metals Corporation Ltd., especially in the export markets. The third blast-furnace at Newcastle, Natal, and extensions providing, *inter alia*, for the required higher tonnages of iron ore and dolomite have been completed and commissioned. Annual production of pig iron will henceforth be at higher levels, above the immediate domestic requirements, but the excess is expected to be readily absorbed in export sales. Ferro-alloy productive capacity was substantially increased by the acquisition of Ferrometals, Ltd. at Witbank, but with demand, especially in the export markets, continuing to exceed output capacity, consideration is being given to a further expansion of the works near Vereeniging.

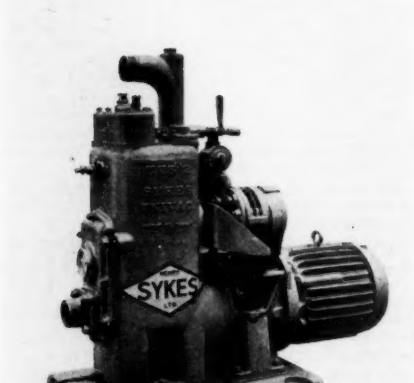
The Corporation reports that its high-grade phosphate deposits in the Langebaan area of the Western Cape are being steadily depleted and research has been stepped up to exploit extensive deposits of lower-grade phosphate rock. The economics of beneficiation and erecting a plant are under consideration, along with intensified prospecting to expand the known reserves. A decision on establishing a joint graphite electrode plant with the Siemens-Plania company will probably be made within the next year; meanwhile investigations continue. The corporation has established a subsidiary in the United Kingdom to provide additional facilities for external buyers.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Face Drainage Pump

An electrically-operated face drainage 2-in. centrifugal pump is now being produced by **Henry Sykes, Ltd.,** of 53b, Southwark Street, London, S.E. 1. This is a self-priming unit known as the "Univac." Its maximum head is 60 ft. but the maximum useful suction lift is 26 ft., allowing the pump to be located well clear of the face while maintaining its rapid self-priming ability combined with high output. Its capacity is 6,500 g.p.h. when operating on a suction lift of 10 ft. at a nominal head. At nominal lift and a total head of 20 ft. the output is 8,000 g.p.h. The pump will pass solids of up to 1 in. diameter and will pump slurries of up to 60% solids content. On a 10-ft. suction the pump will prime in 12 sec., while on a 28-ft. suction the priming time is 65 sec.



The operating principle consists of the maintenance of a partial vacuum in two chambers which are above the centre-line of the pump and which precede it in the suction line. These chambers are interconnected and the partial vacuum is maintained in them by a small rotary vacuum pump. The function of the first of these tanks is to gather any air which may pass up the suction line and to maintain a reservoir of water, the duty of the second tank being to prevent water reaching the vacuum pump. The pump is shown close-coupled to a 3-h.p. English Electric 3-phase 50-cycle 400–440-volt motor.

Mine Car in Aluminium.

Aluminium Mine Cars

A welded aluminium mine car which weighs nearly 50% less than conventional cars is undergoing operational tests in a West Virginia coal mine. The weight savings provided by this vehicle would permit an operator to haul additional 18-ton fully loaded cars without increasing the normal gross train weight. For instance 23 fully-loaded cars of the type being tested would weigh approximately the same as 20 loaded steel cars of equal capacity. The car was fabricated by the **Irwin-Sensenich Corporation,** of Pennsylvania, from 5083 aluminium alloy plate and 6061 alloy extrusions by **Kaiser Aluminium and Chemical Sales, Inc.** The 5083 is a high-strength alloy developed for its excellent weldability, while 6061 is a widely-used structural alloy. The weight of the aluminium car is 6,840 lb., as compared to 12,730 lb. for a steel car of the same size. It measures 26 ft. long, 7 ft. 1 in. wide and 4 ft. 5 in. high. Capacity is 625 cu. ft. and 18 tons of coal.

In addition to its light weight another advantage of aluminium for mine car service is its superior resistance to the corrosive action of the sulphur content of coal. The car is also expected to be less noisy in operation, easier to re-rail, and easier to re-square if the body is damaged.

The body of the car is fabricated from $\frac{1}{4}$ in. 5083 plate and 6061–T6 aluminium extrusions for corner stiffeners and supports. Welding was by the shielded metal arc consumable electrode (MIG) process, with 5183 welding wire used as the combined electrode and filler material. In fabrication, precautions were taken to prevent the possibility of galvanic corrosion where the aluminium body is in contact with the steel undercarriage; zinc chromatic primer was used on the aluminium surfaces and steel surfaces were cleaned, primed, and given two coats of paint and a compound applied between the mating surfaces.

Rock-Drill with Integral Airleg

By making the airleg an integral part of their new Silver Thirty-Three rock-drill, **Holman Bros., Ltd.,** of Camborne, have been able to group all controls within easy reach of the operator's hand. All the operating air enters the machine through a single hose and is distributed internally by controls situated in the backhead. The airleg control is of the roller ratchet type and the main throttle also controls the flow of water to the drill bit. This grouping of controls gives easier and quicker operation, while the built-in water control automatically ensures a flow of water immediately drilling starts.

Following the usual rigorous trials at the company's test mine several of these rock-drills are already at work in Canada and are

Rock-Drill with Integral Airleg.

proving highly popular, it is stated. The drill has a 3-in. bore and $1\frac{5}{16}$-in. stroke with a shank length of $4\frac{1}{2}$ in. and the airleg has a feed length of 58 in. The total weight is 105 lb. The illustration shows a West African student of the Camborne School of Mines operating the drill at the test mine.

Conveying up Steep Gradients

Some notes have recently become available concerning a new principle to overcome the tendency of materials being conveyed up steep gradients to roll or slip (Fig. 1). This has been developed by a German company and **Richard Sutcliffe, Ltd.,** of Horbury, Wakefield, hold the British manufacturing rights.

By this system an endless belt of flexible chain matting is laid over the load on the conveyor-belt to prevent the materials from rolling or slipping (Fig. 2). The weight of the mat will depend partly on the nature of the material and partly on the conveying angle involved. The chain mat moves at the same speed as the main conveyor-belt but is itself carried independently by a supporting belt driven from a single-drum drive unit mounted on a loading frame. Material need not be

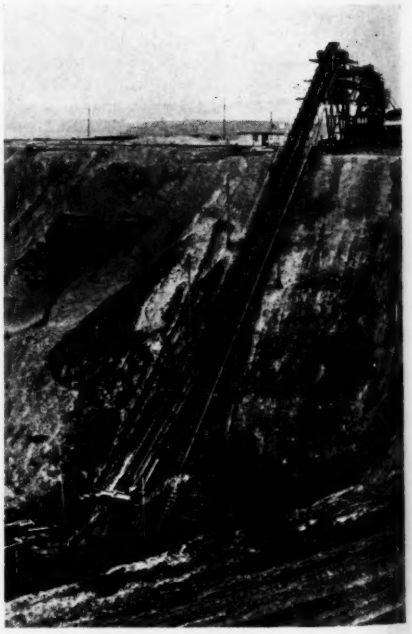


Fig. 1.

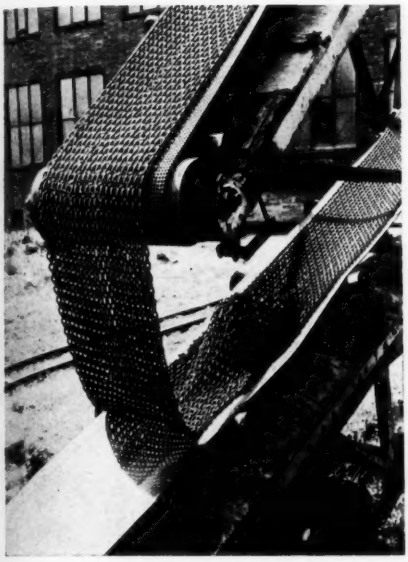


Fig. 2.

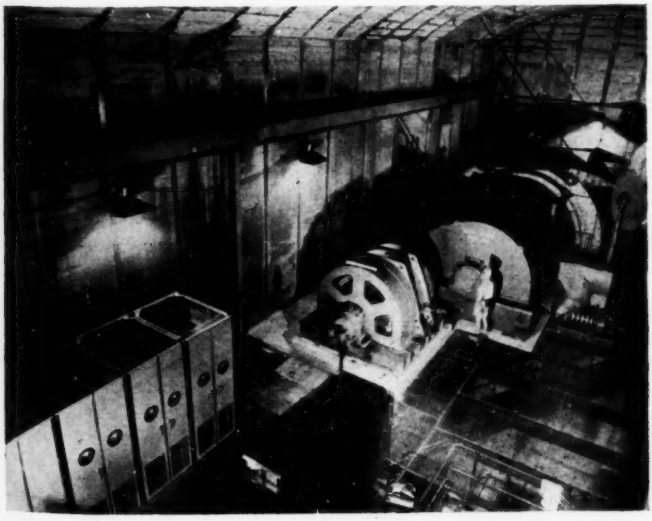
sorted before being loaded on to the conveyor-belt for the longitudinal and transverse flexibility and the crosswise expansibility of the chain mat allows even the largest lumps to be covered and prevents the escape of adjacent material. A special steel covering can be used to protect the conveyor-belt itself when abrasive ores are being carried.

In addition to covering the material and increasing the friction between the material and the conveyor-belt by its weight the chain mat assumes approximately 40% of the total conveying effort. When the conveyor-belt is empty the chain mat simply lies on it and moves with it. The angle of the belt can be altered as necessary and it has been found that incomplete loading and stopping have no effect upon the ability of the chain belt to hold the charge without slip.

Mine Winder with Mercury-Arc Conversion

In the 2b Tertiary Shaft at Venterspost at a depth of 6,000 ft. the Consolidated Gold Fields of South Africa have commissioned the first d.c. mine winder in Africa supplied from a grid-controlled mercury-arc rectifier. This is stated in a recent note issued by **Associated Electrical Industries, Ltd.,** Heavy Plant Division, of Rugby, which company has supplied the complete electrical equipment.

The winder, which works in an ambient temperature of 85° F. (wet bulb) (90° dry bulb), is driven by an A.E.I. 1,200-h.p. 520-r.p.m. motor. Operating in a shaft 3,800 ft. long, inclined at an angle of 34° to the horizontal, its hourly output of ore is 185 tons. It may be noted that the first mine winder in Britain supplied by a mercury-arc converter was installed by the company in 1954. Since



A.E.I. Winder at Venterspost.

Vibro Dewaterer.

then seven similar A.E.I. winders have been installed, three of them being of the multi-rope tower-mounted type.

In an underground winding house such as that at Venterspost a mercury-arc converter has, it is suggested, the following advantages : (*a*) Power consumption is less than that with conventional equipment ; (*b*) standing losses are smaller ; (*c*) heat dissipation is less (with an a.c. winder it would be almost twice as much) ; (*d*) the winder and its associated equipment can be accommodated in a smaller space and lighter foundations can be used ; (*e*) the installation is quieter than rotary equipment, and (*f*) since the conversion equipment is static, maintenance is reduced.

Sand Dewatering

An application of the Rheax hydraulic classifier to sand dewatering has recently been made known which may be of interest to mineral-dressing engineers. This is the tilting thickener which is in effect a refinement of the conventional type of dewatering cone but with the added advantage of having one main collection pocket and one secondary collection pocket as well as an overflow so that no pieces are lost in the overflow and the density of the slurry delivered is both high and constant. There has also been developed a machine known as the Vibro Dewaterer (VDW 30) by means of which it is possible to dewater sand so that no free water is left. The principle in this case is that the sand (or perhaps mineral concentration) is vibrated on an inclined plate on which it tends to stratify so that the water runs back and the dewatered material is vibrated or shaken over the top edge.

It is thus possible to offer a tilting thickener and vibro-dewaterer together with a pre-concentration cone as a " dewatering tower " which will receive a pumped feed, strip out reasonably clean water, and deliver a concentrate sufficiently dewatered on to a conveyor belt. The Vibro Dewaterer is shown in the accompanying illustration.

This information is made available by **Millars' Machinery Co., Ltd.,** Technical Services Division, of 214A, High Street, Hounslow, Middx., on behalf of Chemie und Metall GmbH, Wollzeile 12, Vienna, Austria.

Personal

ROBERT G. AXTELL has been appointed to the newly-created position of director of marketing (fabricating operations) for the Cerro de Pasco Corporation.

V. N. BURNHART has been elected president of the E. J. Longyear Co., following the death of Dr. D. M. Davidson.

GEORGE H. CLEAVER has been appointed manager of market research, Amco Division of American Metal Climax, Inc.

J. A. COWPERTHWAITE is home from S. Rhodesia.

E. M. DAVEY has left for Nigeria.

A. F. EPSTEIN, well-known in international ore and mineral markets, has joined Ayrton and Partners, Ltd., and will be in charge of their ore department.

E. FAIRFAX is now with the Tsumeb Corporation in charge of the new copper and lead smelter project.

ALAN S. GILL has retired from the board of George Cohen, Sons, and Co., and is now practising as an independent consultant.

JAMES C. GRAY, of Pittsburgh, administrative vice-president, Raw Materials, U.S. Steel Corporation, has been elected president of the Society of Mining Engineers.

WILHELM HAGLUND, president of the Sandviken Steelworks Co., Ltd., Sandviken, Sweden, visited this country early this month.

P. K. HALL has left for Sierra Leone.

D. G. HEMMANT has tendered his resignation and will not be returning to Powell Duffryn Technical Services, Ltd., at the conclusion of his secondment to the British Mining Equipment Export Association. R. TURNER, who has acted as managing director during Mr. Hemmant's absence, has been appointed the sole managing director of the company.

W. HUDDLESTON, of the Atomic Staff of the Springfields Atomic Factory, Salwick, Lancs., is to receive the first award of the newly-created Ellis Medal for Works Management.

J. HUMPHRISS has left for Northern Rhodesia.

E. A. JAQUES has left for Ghana.

A. W. LEHMANN has returned to Chile.

R. H. MACWILLIAM has been appointed a director of Union Corporation, Ltd., and its associate company, Bay Hall Trust, Ltd.

RONALD R. MCNAUGHTON, of Trail, British Columbia, has been elected president of the American Institute for 1961.

RICHARD MILES, who retired recently as chairman of Head, Wrightson and Co., Ltd., has been appointed a director and chairman of Joy-Sullivan, Ltd.

F. W. A. TIMME is home from Kenya.

P. W. WATSON has left for Ghana.

F. G. ATHERTON, a mining engineer and a former director of the Cementation Company, Ltd., died on September 11, after a prolonged illness. He was a recognized authority on shaft sinking problems and ground engineering techniques.

GEORGE ARCHER, president of the Mond Nickel Company, was taken ill in his office and died in Westminster Hospital, on September 20. Mr. Archer, who was appointed president in July of this year, had been chairman of the company and its subsidiary, Henry Wiggin and Co., Ltd., since July, 1959.

DONALD M. DAVIDSON, president of the E. J. Longyear Company, Minneapolis, and a geologist with a world-wide reputation, died suddenly and unexpectedly on September 15, aged 58. He had been president of the Longyear Company since June, 1958. Dr. Davidson was a member of the American Association for the Advancement of Science, the American Institute of Mining Engineers, Canadian Institute of Mining Engineers, Geophysical Union, Washington Geological Society, a fellow of the Geological Society of America, a member of the Mining and Metallurgical Society of America and of the Institution of Mining and Metallurgy.

Metal Markets

During September [1]

Copper.—By and large September, like August, was a month in which the overall surplus of copper supplies had most effect on the market. It might almost be said the only effect of any consequence, for although there were small rallies, particularly in the first half of the month, prices generally tended downwards, despite such bullish considerations as the continued uncertainty of the Congo situation—even now the possibility of some interruption in future supplies from that region cannot be entirely ruled out—and the growing threat of a strike at the Anaconda Company's property at Chuquicamata, in Chile.[2] The Congo situation was undoubtedly less of a bull factor in September than in any other month since the granting of independence, but the turn of the Chuquicamata negotiations would have certainly given rise to more alarm as the month wore on without any solution seeming nearer had it not been for two factors: First, the extent of the current surplus and, secondly, the fact that any interruption in Chilean production was, in any case, unlikely to make itself felt for some weeks until the "pipeline" was emptied.

Few people, it seemed, expected a strike to last long enough to make itself felt, if, indeed, one broke out at all, and even the fact that Chuquicamata workers voted "overwhelmingly" in favour of strike action only days before the deadline failed to cause any reaction on the market other than a temporary pause in the downward drift of prices. The general feeling was that at worst the Chilean Government would intervene—indeed, such intervention had been promised—and with the impact of a prolonged strike likely to be disastrous to the Chilean economy at the present time, when it is still suffering badly from the effects of the earthquakes earlier this year, it would probably take drastic measures if necessary to secure an early resumption of work. At the time of writing it seems likely that the strike will be called off almost before it has begun. The executive of the union concerned has accepted Anaconda's latest offer.

Consumption of copper in the United Kingdom in July was 46,306 tons, of which 33,394 tons was refined. Production of primary refined copper in this country in July amounted to 7,004 tons, while that of secondary refined was 6,326 tons. Stocks of refined copper rose sharply from 56,257 tons to 77,918 tons while blister stocks jumped from 15,134 tons to 20,165 tons.

Tin.—Broadly steady conditions continued to prevail in tin throughout September with one important exception, largely a technical point. It so happened that a number of contracts entered into at a time when the London market was more attractive than Singapore from the price point of view matured when the market was only thinly

[1] Recent prices, pp. 200, 240.

[2] See Table, p. 240.

supplied—hence a slight squeeze.[1] On the other hand, the persistence of a small backwardation throughout the rest of the month served as a constant reminder that the nearby supply situation was by no means easy and there was always the feeling that any sudden spurt of consumer buying, which had for the most part kept up at a steady rate except in the United States, could have resulted in a further shortage and another jump in prices.

Such considerations apart, the prospect that caused most concern was the possibility of a sudden rush of metal on to the market from Malayan producers' stocks. Various reassurances were given during the month, but these did not prevent observers in the trade from keeping a watchful eye on the daily turnover on the Singapore market in the latter part of September, as an indication of likely tonnages. However, until the very end of the month there were no signs of any large-scale marketing from stocks, which could have had a depressing effect on prices. On September 30, however, the last day of quota restrictions, Singapore offerings were exceptionally heavy by recent standards and this tended to reawaken fears (otherwise receding rapidly) that the market might be in for some upset in the last quarter.

The other event of significance in September was the decision of Consolidated Tin Smelters, Ltd., to establish a smelter in Nigeria. It will undoubtedly mean something of a setback to United Kingdom tin production if it goes through, since Nigerian tin concentrates have hitherto all been sold under contract to a Consolidated Tin subsidiary company in this country for smelting.

United Kingdom tin consumption in July amounted to 1,638 tons. Production was 1,894 tons and stocks at the end of the month again showed a rise at 11,979 tons.

Lead.—Just how unhealthy the lead market is these days was amply illustrated by September's prices on the London Metal Exchange.[1] They had been below £70 a ton at one time in August, but then they had rallied almost immediately, because consumers were attracted by such a low price to step in and increase their buying. But when they dropped below £70 again midway through September consumers showed not the slightest interest, because the Lead and Zinc Study Group's communiqué, following its meeting in Geneva in the early part of the month, was seen to indicate just about as easy a supply prospect for the next few months as anyone could have wished for.

It is not surprising, therefore, that consumption, which has been on the low side since the August holidays, showed little or no revival in September. Quite apart from the fact that future consumer activity was clouded by talk of a recession in certain sectors of industry the overall market position gave dealers little or nothing to go for. Consequently what consumer buying there has been recently has tended to be on a day-to-day needs basis only and such may well be the pattern for some time to come.

Lead consumption in the United Kingdom in July amounted to 27,913 tons. Output of English refined lead in the same period was 5,959 tons. End-month stocks rose sharply from 46,542 tons to 53,069 tons.

Zinc.—The International Lead and Zinc Study Group came out with a depressing picture of zinc and its prospects in the communiqué issued after its meeting in Geneva in the early part of September. Its estimates spoke of a zinc surplus this year of 74,000 tons against the *deficit* of 78,000 tons forecast when it met earlier in the year. Consumption was reasonable throughout—though helped in no small way by the fact that Japan and India were in the market for some good tonnages—but the future outlook for the market [1] as a whole continues to depend on the overall level of consumer activity outside the U.S. There is, and has been since the Geneva communiqué, a strong feeling that the position is by no means as bad as the Study Group indicated. For one thing, as indeed was soon pointed out, the shift from expected deficit to expected surplus is largely explained by the fact that the estimate for U.S. consumption this year has been reduced by more than 100,000 tons. However, with zinc, as with lead, the U.S. quota system effectively isolates it from the rest of the market. Again, while the Group estimated that 1961 supplies would be in surplus to the extent of more than 100,000 tons it also admitted that its consumption estimate for the same period could well be 50,000 tons too low.

One other factor—and one which is receiving increasing attention, as indicated in last month's report—is the growing stringency in concentrate supplies. All the foregoing presumes a good supply of concentrates, all the time.

U.K. zinc consumption in July was 25,594 tons. Output was 5,910 tons and stocks at July 31 amounted to 55,362 tons.

Iron and Steel.—September saw the resumption of full-scale working in the British iron and steel industry following the holiday interruptions in the previous two months. The steelworks have been kept very busy trying to meet consumers' heavy demands for a wide range of products and full order books assure maximum operations until the end of the year at least. The level of production this year has been impressive and the industry's "target" of 24,000,000 ingot tons is confidently expected to be reached and possibly exceeded. However, at this moment of steel's prosperity, there is a number of signs which suggest that the current boom has reached its zenith. The Government's tighter-money policy has come at an unfortunate moment for one of the industry's most important customers, the motor trade. The drop in home sales has taken place at the same time that it is having difficulties in the export market, particularly the U.S.A., where the new "compact" cars are competing with imported models. Already some car companies have begun restricting production by cutting overtime and in a few cases working hours have been cut. This has eased the pressure of demand for sheets.

During the period of intense demand for sheet steel imports were increased to a very high level indeed (they totalled 510,458 tons in the first eight months of this year) and the easing in demand will mean that foreign supplies will now be needed only marginally.

Most of the heavy-rolling mills are favourably placed, in spite of the restricted flow of orders from certain customers, including the railways and the shipyards. The steel industry's own large expansion programme is providing a good outlet for heavy steel and the building industry has been a notable consumer of heavy sections and reinforcing rounds, while the big road programme is also taking considerable tonnages. A recent development in the heavy end of the trade has been the coming into

[1] See Table, p. 240.

[1] See Table, p. 240.

operation of two large plate mills on the north-east coast.

Competition in the export market is intense and British salesmen have been having a restricted success in some fields. The Commonwealth countries are still our best customers, with Canada and India the leading countries. Sweden (a fellow-member of the European Free Trade Association) has also taken substantial tonnages of British iron and steel.

Iron Ore.—Reflecting the heavy requirements of the blast-furnaces in this country, imports of iron ore in the first eight months of the year climbed to 11,900,000 tons, an increase of more than 3,900,000 tons over the same period of 1959. Of the total 3,100,000 tons were imported from Sweden and over 2,000,000 tons from Canada, while Algeria and Venezuela supplied almost 1,400,000 tons and 1,100,000 tons respectively. Extraction of domestic ore has also been at a high level, averaging 323,500 tons a week in the first seven months, as compared with 282,300 tons in the same period of last year.

Aluminium.—The main news on the aluminium front in September was again from Australia, where Consolidated Zinc and British Aluminium decided to part company in so far as their joint venture, Commonwealth Aluminium, was concerned. A joint statement said that Consolidated Zinc would buy B.A.'s shareholding at par, in return for which B.A. would stand in place of Comalco in negotiations now taking place with the Australian Government about the purchase of the Government's interests in a New Guinea prospecting venture, of which B.A. is already part owner. At the same time it would take over from Commonwealth Aluminium (Comalco) the lease of certain bauxite deposits in the Northern Territory.

Comalco is to continue the development of bauxite deposits at Weipa, in northern Queensland—the purpose for which it was originally set up in 1956—and, indeed, now that its sole parent organization, Consolidated Zinc, and the Tasmanian Government have decided to acquire between them the Australian Aluminium Production Commission's Bell Bay plant (as reported last month), everything is regarded as being ready for the start of the real Weipa programme. In four years' time it is hoped to have Weipa producing alumina in quantity—the cost of the project is estimated at £34,000,000—and to have expanded Bell Bay, which will use Weipa alumina, to a capacity of 28,000 tons a year. It might then be possible to produce aluminium at Bell Bay for sale at a price on the Australian market £37½ a ton cheaper than to-day, according to some reports.

Following the British Aluminium and Consolidated Zinc move the position in Australia then returns to what it was some three years ago before B.A. entered into the Comalco project. In other words, the Australian aluminium industry is once again in the hands of large unrelated interests and as such its overall progress in coming years may well be faster than if the various facets had had to be fitted into one general programme.

Elsewhere as regards the primary metal September's main news centred on Norway, where leading industrialists were told the country had good prospects of improving its current position as a major world producer. Apparently several foreign firms have expressed interest recently in setting up new plants in Norway, which is attractive to them on account of its abundant hydro-electric power resources.

Antimony.—The current strength of the ore market, which recently resulted in prices being raised by 1s. a unit all round, as mentioned in last month's report, was further reflected in September by a £10 increase in the price of English antimony regulus. The increase, which became effective on September 12, means that the rates per ton, delivered, are now £200 and £207 10s. respectively for 99% and 99·6% material. The change was the first for more than three years and was said by the producers to have been made necessary by the fact that it was no longer possible to absorb the latest increase in raw-material costs.

Almost immediately imported Chinese antimony was also increased by £10 a ton, so that 99% is now quoted at about £147 c.i.f. per metric ton, excluding duty; similarly metal of 99·6% purity is now quoted at about £153 per metric ton. However, new offerings of Chinese shipment metal have virtually stopped for the present. Some reports indicate that this may be due to a shortage of material and, according to some observers, it may well be that all this year's supplies have already been disposed of. Similar reports have been heard with regard to Russian antimony.

Arsenic.—Again in September there was little or no fresh activity with regard to trading in arsenic and the metal is still quoted so far as the United Kingdom is concerned at £400 a ton. As for the trioxide, the ex-store price is still £40 to £45 a ton.

Bismuth.—Despite the growing interest in bismuth referred to in last month's report the price continues to hold at a nominal 16s. a lb. for 1-ton lots.

Cobalt.—The situation as regards cobalt remained much the same in September as of late, with continued anxiety in some quarters over future supplies in view of the Congo situation. However, the confusion in the Congo has been with us for some little time now and it may well remain for some time to come. For the moment there is no tendency for prices to be moved either up or down from the levels of recent months. U.K. contract material therefore remains quoted at 10s. 9d. a lb., delivered to customers, while the open-market price is still 12s. a lb.

Cadmium.—With little or no change from August in conditions with regard to supplies or consumption of cadmium, prices have remained steady since our last report at 10s. 6d. per lb. for U.K. and Empire material and 10s. 6d. to 10s. 9d., duty paid, for foreign, both delivered to consumers. As this report was written foreign (U.S.) cadmium was advanced to 11s. in the U.K.

Chromium.—Chromium metal was again quoted at 6s. 11d. to 7s. 4d. per lb. throughout September.

Tantalum.—The present quoted price for tantalite is still 700s. to 750s. per unit for material assaying 60% Ta_2O_5, but while, as reported last month, some users feel rather differently from others at present as to just how much they are prepared to pay it may soon prove on balance that the majority are prepared to pay prices above this range.

Platinum.—September was another very quiet month for platinum, with prices unchanged throughout at £30 5s. per troy oz. for U.K. and Empire refined material and £28 5s. to £28 15s. for open-market material.

Iridium.—The recent down-drift in iridium prices seems to have been arrested, at least temporarily. Although trading conditions remain quiet the price at the end of September was again £20 to £26 15s. per troy oz.

Palladium.—Quotations have again held at £8 10s. to £9 7s. 6d. per troy oz., in spite of only very quiet trading.

Osmium.—September was another inactive month for osmium and prices remained throughout at £18 to £25 per troy oz.

Tellurium.—Midway through September tellurium producers increased their selling price for the second time recently. The new rate for lump and powder of 99% to 99·5% purity is 28s. 6d. per lb., against 25s. previously (a price fixed in May). Demand is said to be somewhat on the increase at present. Tellurium sticks were still being quoted at the end of the month at 40s. per lb.

Tungsten.—September was a very steady month for tungsten ore with prices quoted from first to last at 155s. to 161s. per long-ton unit, c.i.f. The market was moderately active all through the month with most business being done here and on the Continent. There was only very little inquiry from the Far East and elsewhere, despite the fact that for some weeks past dealers had been confidently forecasting that renewed interest was likely to make itself felt at any time. Towards the end of the month U.K. demand became more patchy and the feeling at the very end was that " weak " sellers might make their appearance shortly unless any really spectacular inquiry developed.

Nickel.—The one event of any real note so far as nickel was concerned in September was the pronouncement before the U.S. Tariff Commission by Mr. J. C. Carrington, vice-president of Freeport Nickel, that his company hoped to resume output at Moa Bay eventually. Prior to this, it has been reported, there had been rumours to the contrary. Of course everything still depends on an improvement in the political situation in Cuba and on the sorting out of present Cuban-American differences. When such an improvement can be expected is another matter.

Also last month there were reports that the long-threatened Cuban seizure of the U.S. Government's Nicaro project might well not go through after all, because of objections by local employees. At the moment it still is not clear under what conditions production was being carried on, but at least shipping permits for dispatches of nickel to the U.S. were apparently still being issued, although on September 30 the U.S. Government announced that conditions were such that it was closing the plant " almost immediately."

Refined nickel is still quoted at £600 a ton.

Chrome Ore.—Chrome-ore deliveries continued steadily during September on the basis of existing contracts. Towards the end of the month U.K., Continental, and other buyers began inquiring about their 1961 supplies. Nevertheless, the feeling in the market is still one of only quiet optimism at best. Any new business is thought to be unlikely to lift prices from their existing low levels, although at least it should prevent any further downward movement. Rhodesian metallurgical ore is again quoted at £15 5s. per ton, c.i.f.

Molybdenite.—September, like August, was an uneventful month for the molybdenite market and Climax material was again quoted throughout at 8s. 11d. per lb. Mo f.o.b. mine. From other sources the quotation remained at 9s. 3½d. c.i.f.

Manganese Ore.—Lower European offering prices for manganese ore followed the announcement at the beginning of September of a cut in the Indian freight rate. The new figure, 66d. to 71d. per unit, is, however, still somewhat academic since there has long been a wide gap between buyers' and Indian sellers' ideas of realistic prices.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum, 99·75% ; Copper, electro ; Lead, minimum 99·75% ; and Zinc, minimum 98% per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Sept. 9	802 0	799 15	235 2½	235 12½	70 6¼	70 13¾	86 16½	86 7½
12	808 0	803 10	235 2½	235 12½	70 8¾	70 13¾	87 18¾	87 13¾
13	818 0	810 10	234 2½	234 12½	70 18¾	71 1¼	88 16½	88 1¼
14	811 0	805 10	235 7½	235 17½	70 18¾	71 1¼	88 12½	87 17½
15	805 0	801 15	236 7½	237 2½	70 6¼	70 13¾	89 2½	88 7½
16	805 10	802 5	236 17½	237 7½	70 7½	70 12½	88 6¼	87 16½
19	806 0	803 5	237 17½	237 17½	70 3¾	70 6¼	87 10	87 2½
20	805 10	802 15	236 7½	236 7½	69 18¾	70 1¼	86 7½	85 17½
21	807 0	804 15	236 7½	237 2½	69 18¾	70 3¾	87 2½	86 6¼
22	806 10	804 5	235 2½	236 2½	69 12½	69 16¼	87 6¼	86 3½
23	806 0	803 15	234 2½	235 2½	69 7½	69 16¼	87 6¼	85 18½
26	805 0	801 15	233 2½	234 2½	68 12½	68 17½	86 17½	85 12½
27	805 0	801 15	232 7½	233 7½	68 12½	68 18¾	86 17½	85 11½
28	806 10	803 5	231 17½	233 2½	68 12½	69 7½	87 17½	86 1½
29	804 10	801 15	230 17½	232 2½	68 13¾	69 5	87 2½	85 10
30	804 0	800 15	230 12½	231 17½	68 15	69 8¾	86 17½	85 8¾
Oct. 3	803 0	799 15	225 2½	226 17½	68 7½	69 17½	86 7½	86 12½
4	802 0	798 5	226 12½	228 12½	68 10	69 17½	87 2½	87 2½
5	804 0	799 15	225 17½	227 17½	67 10	68 17½	87 7½	86 17½
6	805 0	800 10	223 17½	225 12½	66 17½	68 13¾	87 6¼	87 3½
7	807 10	801 0	224 17½	226 12½	66 3¾	68 1¼	87 7½	87 7½
10	808 10	801 10	225 7½	227 2½	66 10	68 5	87 16¼	87 7½
11	811 0	801 5	226 2½	227 17½	66 6¼	68 3¾	88 16¼	88 1¼

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	August		September	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	138,000	89,706	133,000	86,464
Brakpan	146,000	17,558	142,000	17,336
Buffelsfontein‡	145,000	59,979	148,000	61,190
City Deep	119,000	23,723	117,000	23,588
Cons. Main Reef	59,000	11,635	53,000	11,499
Crown Mines	206,000	35,129	201,000	34,148
Daggafontein	230,000	46,575	228,000	46,183
Dominion Reef	39,300	479	44,200	470
Doornfontein‡	105,000	43,302	105,000	43,297
D'rb'n Roodeport Deep	198,000	36,186	192,000	35,315
East Champ D'Or‡	12,000	334	12,500	364
East Daggafontein	107,000	18,190	106,500	18,212
East Geduld	134,000	38,525	129,000	37,410
East Rand P.M.	245,000	54,457	223,000	52,526
Eastern Transvaal Consol	19,200	6,174	19,400	6,071
Ellaton‡	28,000	6,615	28,000	6,596
Freddies Consol.	64,000	13,711	64,000	13,338
Free State Geduld	95,000	82,100	95,000	82,151
Geduld	78,000	12,675	80,000	13,008
Government G.M. Areas‡	54,000	11,008	52,000	10,436
Grootvlei Proprietary	227,000	46,902	223,000	46,164
Harmony Gold Mining	173,000	69,263	162,000	66,014
Hartebeestfontein‡	120,000	55,802	120,000	56,100
Libanon	117,000	27,960	117,000	27,961
Loraine	82,000	17,429	82,000	17,429
Luipaards Vlei‡	120,000	13,513	120,000	13,425
Marievale Consolidated	101,000	24,594	98,000	24,059
Modderfontein East	138,000	12,972	128,000	12,110
New Kleinfontein	77,000	10,467	77,000	10,388
New Klerksdorp‡	9,700	1,011	11,000	1,201
President Brand	118,000	95,643	116,500	94,346
President Steyn	103,000	38,401	105,000	39,523
Rand Leases	196,000	28,126	188,000	27,166
Randfontein‡	168,000	13,221	161,000	10,666
Rietfontein Consolid't'd.	15,000	3,985	15,000	3,907
Robinson Deep	43,000	9,978	46,000	10,260
Rose Deep	23,000	4,496	26,000	4,470
St. Helena Gold Mines	179,000	62,207	178,000	61,855
Simmer and Jack	75,000	13,310	75,000	13,297
S. African Land and Ex.	101,000	20,957	100,500	20,854
S. Roodepoort M.R.	31,000	7,391	30,000	7,177
Spaarwater Gold	11,000	3,431	11,000	3,433
Springs	98,000	13,668	96,000	13,349
Stilfontein Gold Mining‡	168,000	76,300	168,000	76,400
Sub Nigel	66,500	15,282	66,500	15,219
Transvaal G.M. Estates	7,300	2,075	—	—
Vaal Reefs‡	103,500	46,575	101,000	46,460
Van Dyk Consolidated	78,000	12,479	75,000	11,863
Venterspost Gold	125,000	34,981	126,000	35,362
Village Main Reef	29,500	4,336	28,000	3,960
Virginia O.F.S.‡	56,000	11,766	129,000	27,232
Vlakfontein	52,000	18,828	52,000	18,811
Vogelstruisbult‡	85,000	18,343	85,000	18,326
Welkom Gold Mining	100,000	31,781	100,000	31,852
West Driefontein‡	130,000	121,506	130,000	129,541
West Rand Consol.‡	213,000	21,550	208,000	20,883
Western Holdings	157,000	104,251	157,000	104,800
Western Reefs	143,500	40,683	138,500	39,473
Winkelhaak	95,000	31,351	95,000	31,825
Witwatersrand Nigel	20,000	4,438	20,000	4,432

† 250s. 0d. * 249s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION*

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept. 1959	18,214,200	70 5	45 2	25 3	30,140,529
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,670,000	72 2	45 10	26 4	30,559,937
Jan., 1960	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,464,400	72 8	46 5	26 3	30,105,571
April	—	—	—	—	—
May	—	—	—	—	—
June	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	—	—	—	—	—

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
September, 1959	1,701,485	36,567	1,738,052
October	1,718,916	33,576	1,752,492
November	1,688,379	34,903	1,723,282
December	1,662,043	31,309	1,693,352
January, 1960	1,701,110	34,651	1,735,761
February	1,675,248	38,859	1,714,107
March	1,664,514	38,744	1,703,258
April	1,734,310	36,720	1,771,030
May	1,765,880	37,897	1,803,777
June	1,775,335	37,530	1,812,865
July	1,776,141	39,673	1,815,814
August	1,778,711	36,777	1,815,488

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
December 31 1959	354,058	31,963	386,021
January 31, 1960	372,254	31,993	404,247
February 29	385,027	32,144	417,171
March 31	388,860	30,696	419,556
April 30	385,841	—	—
May 31	383,212	30,933	414,145
June 30	380,593	31,435	412,028
July 31	378,626	31,879	410,505
August 31	374,303	32,321	406,624

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Sept. 17		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	25,900	4,331	4,771
Electrolytic Zinc	15,127	723	4,002
Lake George	12,003	934	1,855
Mount Isa Mines**	63,368	3,940†	3,602
New Broken Hill	56,640	6,703	13,055
North Broken Hill	28,654	5,733	6,088
Zinc Corp.	73,830	10,658	13,878
Rhodesia Broken Hill*	—	—	—

* 3 Months, ** Copper 3,795 tons blister; 7,126 tons concs.; † Metal.

RHODESIAN GOLD OUTPUTS

	August		September	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	21,000	4,084	21,500	4,178
Globe and Phœnix	6,000	2,898	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	2,899	—	—	—
Coronation Syndicate	12,034	—	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	August		September	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	54,105	12,625	—	—
Ariston Gold Mines	39,480	11,498	—	—
Ashanti Goldfields	36,500	29,500	36,500	30,650
Bibiani	33,000	7,200	32,000	7,100
Bremang	—	4,375	—	—
Ghana Main Reef	12,376	4,189	—	—
Konongo	7,210	3,421	7,450	3,522
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1959		1960	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	46,489	18,077	44,902	29,711
February	43,366	19,806	45,754	29,865
March	48,397	17,394	45,309	29,656
April	46,315	5,694	48,607	6,847
May	46,423	46,280	47,542	62,912
June	49,995	31,386	45,884	34,298
July	46,512	32,734	—	—
August	38,727	29,178	—	—
September	56,760	33,837	—	—
October	48,528	32,314	—	—
November	47,916	31,092	—	—
December	47,452	31,175	—	—

WESTRALIAN GOLD PRODUCTION

	1958	1959	1960
	Oz.	Oz.	Oz.
January	66,562	63,924	64,794
February	65,965	65,035	66,789
March	65,420	65,408	61,941
April	60,855	62,686	65,373
May	64,196	64,184	66,682
June	67,929	74,590	74,502
July	81,106	78,974	67,623
August	68,610	—	67,466
September	68,744	—	—
October	70,128	70,427	—
November	67,562	68,858	—
December	120,106	117,474	—
Total	867,187	861,122	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Aug. 16		To Sept. 13	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,048	7,560	14,032	9,006
Gold Mines of Kalgoorlie	40,710	10,686	40,298	10,296
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	33,550	5,128	35,057	5,937
Lake View and Star*	—	—	—	—
North Kalgurli	29,514	6,982	—	—
Sons of Gwalia	12,502	2,533	12,070	2,529
Mount Morgan	—	4,134	—	4,380

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
April, 1959	776,583	225,027	32,778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	774,749	221,814	32,172	7,498,030
August	683,819	191,598	29,141	6,428,545
September	754,208	213,772	34,139	7,116,556
October	794,030	227,192	34,733	7,558,567
November	770,437	227,176	35,262	7,600,949
December	775,803	221,377	40,807	7,388,654
January, 1960	778,103	226,856	27,617	7,550,068
February	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,765,153
June	791,488	223,833	49,765	7,756,490
July	776,749	222,179	37,002	7,664,968

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	August		September	
	Tons	Oz.	Tons	Oz.
Clutha River	—	665	—	693
Lampa (Peru)†	—	—	31,603	—
New Guinea Goldfields	3,861	1,328	—	—
Yukon Consol.	—	$407,000	—	$350,000

† Oz. Silver : Copper, 108 tons ; 80 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1959	246,693	89,162	305,163
Provisional 1959—January	12,946	7,744	14,874
February	23,658	8,493	20,361
March	27,377	9,776	30,402
April	82,992	8,142	23,477
May	25,122	9,400	26,832
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	July	Aug.	Sept.
Ampat Tin	59½	70	68½
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Batu Selangor	—	—	—
Berjuntai	218¼	272½	274
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	—	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	123	171	175
Kamunting	139	139	118½
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	33	25	26½
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	59	61	51
Kuala Kampar	133	96	110
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	10	17½	9½
Lower Perak	160	160½	119
Malayan	—	—	—
Malaysiam	—	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	640*
Pengkalen	—	—	—
Petaling Tin	—	—	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	65½	62½	57
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	35	33	42
Southern Kinta	324	278	297
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	—	—	—
Tambah	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	150	131	166½
Tronoh	—	—	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	August		Sept.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	440	57	411	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	49	—	67	—
Beralt	5	184†	5	183†
Bisichi	47	43	57	38
Ex-Lands Nigeria	42	—	50	—
Geevor	38	—	60	—
Gold and Base Metal	59	6	—	—
Jantar Nigeria	16	20	—	—
Jos Tin	13	—	—	—
Kaduna Prospectors	8	—	8	—
Kaduna Syndicate	19	—	19	—
Katu Tin	45	—	56	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	13	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	73	—	135	—
South Bukeru	—	—	—	—
South Crofty	48	—	72	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	19	3½	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

July, 1960.

Gold	1,816,709 oz.
Silver	191,924 oz.
Diamonds	291,310 carats.*
Coal	3,688,659 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,365 tons of 99·12%.
Tin	214 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	14,584 tons.
Chrome Ore	80,939 tons.
Manganese Ore	111,570 tons.
Lead Concs.	— tons.

* *June, 1960.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		July	Aug.
Iron Ore	tons	1,660,302	1,819,945
Manganese Ore	,,	46,132	61,349
Iron and Steel	,,	225,135	207,299
Iron Pyrites	,,	44,127	35,855
Copper Metal	,,	56,443	50,181
Tin Ore	,,	4,925	4,333
Tin Metal	,,	476	331
Lead	,,	20,087	20,888
Zinc Ore and Conc.	,,	27,348	13,528
Zinc	,,	12,641	11,410
Tungsten Ores	,,	668	569
Chrome Ore	,,	34,489	37,594
Bauxite	,,	32,283	30,317
Antimony Ore and Concs.	,,	—	1,254
Titanium Ore	,,	16,669	19,263
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	47	162
Sulphur	,,	50,320	24,141
Barytes	,,	6,944	4,054
Asbestos	,,	16,727	15,446
Magnesite	,,	8,515	10,773
Mica	,,	1,331	804
Graphite	,,	770	423
Mineral Phosphates	,,	125,506	112,023
Molybdenum Ore	,,	664	751
Nickel	cwt.	46,822	50,961
Aluminium	,,	347,977	527,032
Mercury	lb.	138,289	236,824
Bismuth	,,	100,480	164,043
Cadmium	,,	284,484	278,701
Cobalt and Cobalt Alloys	,,	300,565	285,861
Selenium	,,	23,751	20,331
Petroleum Motor Spirit	1,000 gals.	53,622	56,116
Crude	,,	904,959	1,107,955

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	28	12	6
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		2	9
Arsenic, White, 99/100%	per ton	47	0	0
Barium Carbonate 98-99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	0	0
Boric Acid, Comml.	,,	77	0	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	9	15	0
Copper Sulphate	per ton	77	10	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		7	0
Hydrochloric Acid 28° Tw.	per carboy		11	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	116	15	0
,, Nitrate	,,	110	0	0
,, Oxide, Litharge	,,	106	5	0
,, Red	,,	104	5	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	1
Nickel Sulphate	per ton	180	0	0
Nitric Acid, 80° Tw.	,,	32	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	,,		1	2½
,, Bromide	,,	11	2	6
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		16	0
,, Amyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	92	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	198	0	0
,, Sulphate, 50%	,,	20	13	0
Sal-Ammoniac	,,	70	0	0
Sodium Acetate	,,	63	0	0
,, Arsenate, 58-60%	,,	Nominal		
,, Bicarbonate	,,	18	10	0
,, Bichromate	per lb.		1	0
,, Carbonate (Soda Ash) 58%	,,	16	0	0
,, Chlorate	,,	77	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	10	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	136	0	0
,, Oxide	,,	105	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Sept. 8, 1960 £ s. d.	Oct. 10, 1960 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	3 6 3	3 5 0
Blyvooruitzicht (2s. 6d.)	1 6 6	1 8 3
Bracken (10s.)	1 6 0	1 7 6
Brakpan (3d.)	3 9	4 0
Buffelsfontein (10s.)	2 2 6	2 2 6
City Deep	13 9	14 3
Consolidated Main Reef	13 0	14 6
Crown Mines (10s.)	1 1 3	1 3 0
Daggafontein (5s.)	18 0	19 6
Dominion Reefs (5s.)	10 3	10 3
Doornfontein (10s.)	1 8 6	1 7 9
Durban Roodepoort Deep (10s.)	1 5 0	1 9 9
East Champ d'Or (2s. 6d.)	1 9	1 9
East Daggafontein (10s.)	7 9	8 3
East Geduld (4s.)	16 6	18 0
East Rand Ext. (5s.)	19 0	19 0
East Rand Proprietary (10s.)	1 7 6	1 10 3
Freddies Consol.	2 3	2 0
Free State Dev. (5s.)	4 3	4 3
Free State Geduld (5s.)	6 10 0	6 12 0
Free State Saaiplaas (10s.)	10 0	11 0
Geduld	2 6 3	2 13 9
Government Gold Mining Areas (3d.)	3 0	2 6
Grootvlei (5s.)	18 3	18 3
Harmony (5s.)	1 12 3	1 10 6
Hartebeestfontein (10s.)	2 6 6	2 6 0
Libanon (10s.)	12 3	13 9
Loraine (10s.)	1 4 6	1 4 6
Luipaards Vlei (2s.)	6 9	6 9
Marievale (10s.)	1 5 0	1 5 6
Modderfontein B (3d.)	1 6	1 6
Modderfontein East	12 0	12 6
New Kleinfontein	3 6	3 6
New Pioneer (5s.)	1 11 6	1 11 0
New State Areas (15s. 6d.)	9	7½
President Brand (5s.)	3 4 3	3 2 3
President Steyn (5s.)	1 2 3	1 1 9
Rand Leases (9s. 3d.)	6 0	6 3
Randfontein	14 3	15 3
Rietfontein (3d.)	3 0	3 0
Robinson Deep (5s. 6d.)	4 0	4 3
Rose Deep (3d.)	6 9	6 9
St. Helena (10s.)	3 14 6	3 18 0
Simmer and Jack (1s. 6d.)	1 0	1 3
South African Land (3s. 6d.)	12 9	14 6
Springs (3d.)	1 3	1 3
Stilfontein (5s.)	1 12 3	1 13 6
Sub Nigel (3d.)	8 0	8 3
Vaal Reefs (5s.)	2 2 9	2 5 0
Van Dyk (3d.)	2 6	2 9
Venterspost (10s.)	1 1 3	1 0 9
Virginia (5s.)	3 0	3 3
Vlakfontein (10s.)	15 0	16 3
Vogelstruisbult (3d.)	4 6	4 6
Welkom (5s.)	14 3	14 6
West Driefontein (10s.)	4 6 3	4 10 0
West Rand Consolidated (10s.)	16 9	18 0
West Witwatersrand Areas (2s. 6d.)	3 1 3	3 5 0
Western Holdings (5s.)	6 15 0	7 2 6
Western Reefs (5s.)	1 6 3	1 8 3
Winkelhaak (10s.)	1 4 0	1 4 3
Witwatersrand Nigel (2s. 6d.)	1 0	1 0
Zandpan (10s.)	13 3	13 3
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	15 0	15 0
Coronation (2s. 6d.)	5 0	5 0
Falcon (5s.)	10 6	10 0
Globe and Phœnix (5s.)	1 11 3	1 12 0
Motapa (5s.)	—	—
GOLD COAST:		
Amalgamated Banket (3s.)	9	7½
Ariston Gold (3s. 6d.)	3 6	3 3
Ashanti Goldfields (4s.)	17 9	16 9
Bibiani (4s.)	2 3	2 6
Bremang Gold Dredging (5s.)	2 9	2 6
Ghana Main Reef (5s.)	2 0	2 3
Konongo (2s.)	1 3	1 3
Kwahu (2s.)	5 3	4 9
Offin River (2s. 6d.)	3 3	3 0
Western Selection (5s.)	4 3	3 9
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 6	1 6
Gold Mines of Kalgoorlie (10s.)	8 3	9 0
Great Boulder Propriet'y (2s.), W.A.	11 3	11 3
Lake View and Star (4s.), W.A.	1 6 6	1 8 0
Mount Morgan (10s.), Q.	15 3	14 0
New Guinea Gold (4s. 3d.)	1 9	1 9
North Kalgurli (1912) (2s.), W.A.	9 6	9 9
Sons of Gwalia (10s.), W.A.	2 3	2 6
Western Mining (5s.), W.A.	9 9	10 0

	Sept. 8, 1960 £ s. d.	Oct. 10, 1960 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 6 3	1 5 0
Kentan Gold Areas	1 2 3	1 1 3
St. John d'el Rey, Brazil	4 2 6	4 12 6
Yukon Consolidated ($1)	4 3	4 1
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	19 6	18 3
Esperanza (2s. 6d.), Cyprus	1 9	1 7
Indian (2s.)	5 0	4 6
MTD (Mangula) (5s.)	8 0	7 9
Messina (5s.), Transvaal	19 3	18 0
Mount Lyell (5s.), Tasmania	6 0	5 6
Nchanga Consolidated, N. Rhodesia	2 15 0	2 9 3
Rhokana Corporation, N. Rhodesia	2 11 0	2 10 9
Roan Antelope (5s.), N. Rhodesia	6 3	6 3
Tanganyika Concessions (10s.)	1 11 0	1 10 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	11 3	10 6
Burma Mines (3s. 6d.)	1 6	1 6
Consol. Zinc Corp. Ord.	3 17 3	3 12 6
Lake George (5s.), N.S.W.	4 0	4 0
Mount Isa, Queensland (5s. Aust.)	2 15 0	3 16 3
New Broken Hill (5s.), N.S.W.	2 11 3	2 10 6
North Broken Hill (10s.), N.S.W.	19 6	18 6
Rhodesia Broken Hill (5s.)	7 9	7 6
San Francisco (10s.), Mexico	19 3	16 6
TIN:		
Amalgamated Tin (5s.), Nigeria	10 0	10 6
Ampat (4s.), Malaya	12 6	11 9
Ayer Hitam (5s.), Malaya	1 5 3	1 5 0
Beralt (5s.), Portugal	1 13 3	1 11 9
Bisichi (2s. 6d.), Nigeria	5 6	5 3
Ex-Lands (2s.), Nigeria	3 0	3 3
Geevor (5s.), Cornwall	18 3	19 6
Gold Base Metals (2s. 6d.), Nigeria	2 0	2 0
Hongkong (5s.), Malaya	10 3	9 6
Jantar Nigeria (3s.)	6 0	5 0
Kaduna Syndicate (2s.), Nigeria	2 9	2 9
Kamunting (5s.), Malaya	17 6	17 0
Malayan Tin Dredging (5s.)	1 7 0	1 6 0
Mawchi Mines (4s.), Burma	1 0	1 0
Naraguta Karama (5s.), Nigeria	1 6	1 3
Pahang (5s.), Malaya	12 0	11 9
Siamese Synd. (5s.)	13 9	13 3
South Crofty (5s.), Cornwall	4 3	4 3
Southern Kinta (5s.), Malaya	1 5 3	1 5 6
Southern Malayan (5s.)	1 2 3	1 2 3
Southern Tronoh (5s.), Malaya	1 2 6	1 2 0
Sungei Besi (4s.), Malaya	1 8 6	1 5 6
Sungei Kinta, Malaya	15 0	14 3
Tekka (12s. 6d.), Malaya	9 9	9 6
Tronoh (5s.), Malaya	1 19 6	2 0 3
United Tin Areas (2s. 6d.), Nigeria	2 3	2 3
DIAMONDS:		
Anglo American Investment	11 15 0	12 5 0
Consol African Selection Trust (5s.)	1 3 3	1 1 9
Consolidated S.W.A. Pref. (10s.)	10 6	10 9
De Beers Deferred (5s.)	7 7 6	7 10 3
FINANCE, ETC.		
African & European (10s.)	3 2 6	3 7 6
Anglo American Corporation (10s.)	7 16 3	8 3 9
Anglo Transvaal 'A' (5s.)	1 17 6	1 16 3
British South Africa (15s.)	3 14 6	3 13 9
British Tin Investment (10s.)	1 10 6	1 8 0
Broken Hill Proprietary	3 13 0	3 16 6
Camp Bird (10s.)	10 3	8 3
Central Mining	3 15 0	3 15 0
Central Provinces Manganese (10s.)	1 7 9	1 6 3
Consolidated Gold Fields	3 7 6	3 8 0
Consolidated Mines Selection (10s.)	1 11 0	1 10 6
Corner House	14 6	14 0
East Rand Consolidated (5s.)	2 0	2 0
Free State Development (5s.)	4 3	4 3
General Exploration O.F.S. (2s. 6d.)	4 0	4 0
General Mining and Finance	5 1 3	5 7 6
Hendersons (4s.)	8 9	9 9
Johannesburg Consolidated	2 11 6	2 11 6
London & Rhod. M. & L. (5s.)	5 3	4 9
London Tin Corporation (4s.)	12 6	12 6
Lydenburg Est. (5s.)	13 3	13 9
Marsman Investments (10s.)	2 9	3 3
National Mining	2 6	2 3
Rand Mines (5s.)	3 16 3	4 2 6
Rand Selection (5s.)	2 6 6	2 12 6
Rhodesian Anglo American (10s.)	3 1 9	3 4 3
Rhodesian Corporation (5s.)	2 6	2 6
Rhodesian Selection Trust (5s.)	10 6	9 9
Rio Tinto (10s.)	1 13 0	1 10 9
Selection Trust (10s.)	4 9 3	4 10 0
South West Africa Co. (3s. 4d.)	13 9	10 9
Union Corporation (2s. 6d.)	2 15 6	3 3 6
Vereeniging	4 19 6	5 5 0
West Rand Inv. Trust (10s.)	2 10 0	2 12 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Botanical Prospecting for Uranium

In United States Geological Survey Bulletin 1085–B [1] A. J. Froelich and F. J. Kleinhampl describe "Botanical Prospecting for Uranium in the Deer Flat Area, White Canyon District, San Juan County, Utah." In their introduction the authors point out that the plant-analysis method of uranium prospecting depends on the absorption by plants and the subsequent detection of abnormally large amounts of uranium in areas where large concentrations of this element are available in the rooting medium. The indicator-plant method of prospecting relies on the close relation between selenium- and sulphur-indicator plants and uraniferous ground on the Colorado Plateau where selenium and sulphur are associated with uranium in many places. In the Deer Flat area this prospecting method proved ineffective because the copper-uranium ores of the area are extremely low in selenium and sulphur is an ubiquitous element.

The purpose of prospecting by the plant-analysis method in the Deer Flat area, it is stated, was to indicate localities favourable for the occurrence of uranium deposits in advance of physical exploration, thereby reducing costs.

Deer Flat, a gently-sloping bench on the southwest flank of Elk Ridge, is in the White Canyon mining district, San Juan County. The climate is semi-arid and pinyon and juniper are the most abundant woody vegetation. Big sagebrush, Gambel oak, roundleaf buffaloberry, saskatoon, and Utah serviceberry and true mountain-mahogany, all woody plants, are common locally as are legumes and other herbaceous plants. The Flat is accessible by a graded dirt road.

Geology.—Sedimentary rocks that crop out in the Deer Flat area range in age from Permian to Late Triassic. They form part of the west flank of the Monument upwarp and strike N. 15°–45° W. and dip 1°–7° S.W. Rocks exposed include the Cedar Mesa sandstone member and the Organ Rock and Hoskinnini tongues of the Cutler formation of Permian age, the Moenkopi formation of Early and Middle (?) Triassic age, and the Chinle formation of Late Triassic age.

The rocks of the Chinle formation exposed in the area consist of three units, the lowest of which is the principal ore-bearing unit, the Shinarump member. This rests unconformably on upper beds of the Moenkopi formation which are commonly bleached or altered at the contact. In the Deer Flat area it is generally a ledge-forming, cross-laminated coarse- to medium-grained sandstone with interbedded lenses of sandy conglomerate, sandy siltstone, and grey carbonaceous shale. Some lenses contain sandstone, quartzite, and limestone pebbles, silicified and carbonized wood fragments, clay balls, altered volcanic ash, and fragments of reworked siltstone from the Moenkopi.

The lenticularity of the Shinarump in the area is its most striking characteristic, the authors say. The unit is absent at many places in the northern part of the area and, where present, beds 30 ft. or more thick may thin to a featheredge within 1,000 ft. Thickening of the Shinarump has resulted locally from filling of channels at its irregular basal contact and locally from thickening of the sandstone above, with a resultant thinning of the overlying shale in the Chinle. A maximum thickness of 75 ft. is reported in White Canyon, but the Shinarump rarely exceeds 40 ft. in thickness at Deer Flat. It ranges in altitude from 6,400 ft. in the south-western part to 7,700 ft. in the northern part.

The Shinarump member is conformably overlain by a slope-forming member of the Chinle that consists of grey clay, variegated shale, and siltstone, and lenticular beds of sandstone and conglomerate. A persistent bench-forming thin-bedded micaceous sandstone is about 50 ft. below the top of the unit. A resistant cliff-forming sandstone and conglomerate member of the Chinle, 10 ft. to 100 ft. thick, overlies the slope-forming member and caps Deer Flat.

The uranium-copper ore deposits of the area are principally in the lower part of the Shinarump member where the unit fills channels in the Moenkopi formation. The ore deposits appear to have been localized by fractures in porous rocks which have favourable lithologic or chemical features. Minor uranium deposits are present in other parts of the Shinarump member, in siltstone of the upper part of the Moenkopi, and in the members of the Chinle overlying the Shinarump. The uranium deposits in the Shinarump are irregular in shape and consist of primary and secondary uranium minerals and iron and copper sulphides, sulphates, and carbonates. The uranium minerals are found chiefly in replaced wood as impregnations in sandstone and conglomerate, in clay stringers, along lithologic contacts, and at or near fractures, in that order of abundance.

The deposits at the Hideout and Dead Buck mines, two of the most promising deposits at Deer Flat, are closely associated with very porous and permeable channel-filling rocks of the Shinarump member.

[1] Washington: Superintendent of Documents. Price 65 cents.

Organic matter in the Shinarump member has probably influenced mineralization in some places as both copper and uranium minerals replace logs and other carbonaceous material.

Botanical Prospecting.—Two principal methods of botanical prospecting have been applied to the search for uranium deposits in the Colorado Plateau region—the plant-analysis method and the indicator-plant method. These methods differ in application. By the plant-analysis method plants must be sampled and analysed chemically before any abnormal concentration of elements can be determined, whereas by the indicator-plant method some plant species serve directly as a guide to abnormal concentrations of particular elements in the soil because the continued life of the plants depends on the presence of large amounts of these elements. As has already been noted indicator plants are useless in prospecting the Shinarump member because the sulphur that promotes growth of the plants is not restricted to the uranium deposits but commonly occurs as gypsum in strata above and below the Shinarump.

The plant-analysis method of botanical prospecting is based on the absorption and accumulation of uranium by deep-rooted plants growing on shallow uraniferous deposits. Cannon (1952 and 1953) demonstrated that junipers and pinyons where rooted in mineralized ground absorb significantly large amounts of uranium, thereby indicating areas favourable for further investigations. The uranium is absorbed through the roots and detectable amounts are transferred to the twigs and leaves by the life processes of the plants. The moisture content of the ore-bed and of intervening beds is a prime controlling factor in the absorption of uranium from ore-bodies by plants, but the amount absorbed varies with the species, part of plant sampled, time of year, availability of uranium in the soil, and the structural nature and chemical composition of the country rock. The usefulness of the plant-analysis method is limited by the depth to which plant roots will penetrate. Cannon (1952) stated that under favourable conditions juniper roots will penetrate 20 ft. to 30 ft. or more of sandstone, depending on the amount and location of available moisture.

The plant-analysis method for large-scale botanical prospecting has been made practical by the development of a sensitive method for detecting extremely small amounts of uranium in plant ash (Grimaldi and others, 1954). In this method plant samples are ground and mixed thoroughly, oven-dried, quartered, ashed, predigested in nitric acid, quenchers extracted in ethyl acetate, and the evaporated residue analysed fluorimetrically for uranium content. The results are reported as parts per million (p.p.m.) uranium in the ash. This analytical technique makes the plant-analysis prospecting method practical for large-scale botanical prospecting.

Cannon (1952) has shown that contamination of trees that grow in areas of active mining introduces a source of error in comparative analysis. Contamination near mine entrances and along ore-haulage routes have made anomalous amounts of uranium available to nearby trees. The highest uranium content in ash is consistently obtained from trees growing on or near known deposits that were recently worked or were being mined at the time of sampling.

The washing in water of plant samples obtained from areas of mining activity where contamination by uraniferous dust has occurred generally does not alter their uranium content significantly. Most analyses of washed samples fall within the limits of analytical error of the same samples unwashed. The assay values obtained from trees in areas of mining activity are, therefore, unreliable for comparative purposes. Indicator-plant occurrences along access roads may reflect the increased availability of sulphur and selenium originally contained in newly-disturbed ground or the presence of contaminating material.

Field Method.—Samples of tips of branches from the Utah juniper constituted the chief sample type, but in areas of greatest altitude or of great moisture content, where the Utah juniper was absent, plants sampled were the Rocky Mountain juniper, pinyon pine, common Douglas fir, and roundleaf buffaloberry. Most sampled plants are directly comparable in uranium content, but locally, as in the southern part of Deer Flat, buffaloberry samples contained much more uranium than nearby junipers. Two samples of roundleaf buffaloberry in that area contained about six times and five samples contained about twice as much uranium as nearby junipers. The broad pubescent leaves of the roundleaf buffaloberry make it very suspectible to windblown contamination, probably accounting for the large uranium contents of the two samples. Though samples are too few to be conclusive the comparisons made indicate that roundleaf buffaloberry could be sampled in a plant-analysis prospecting programme.

About 2,000 branch-tip samples from as many trees were collected along approximately 27 miles of the Shinarump member or related rock units in the Deer Flat area. Trees were selected at 200-ft. intervals, where the Shinarump is exposed at 50-ft. intervals when covered by rubble or vegetation, and at 100-ft. intervals where the Shinarump is absent. The ore-bearing strata tested form cliffs and very steep slopes. Back from the slopes thick sequences of younger rocks overlie the test horizon; consequently sampling was restricted to a single traverse line at the top of the ore-bearing unit.

A 1-quart container was filled with branch tips (twigs and needles) collected from the entire periphery of a tree selected for sampling. Sampled trees were tagged, labelled, located on aerial photographs, and plotted as accurately as possible on topographic base maps.

A representative suite of rock samples was collected from barren layers of the upper part of the Moenkopi formation and from outcrops of the Shinarump and other lower members of the Chinle formation as well as from mineralized Shinarump at most known prospects. The rocks were analysed for uranium, equivalent uranium, vanadium, and selenium in order to provide information on the background content of these elements in rocks of Late Triassic age in the area.

The differences in uranium content of plants sampled in the Deer Flat area are generally indicative of a barren or mineralized rooting medium. The minimum uranium content in sampled plants for indicating mineralized ground was established in the field by comparing uranium assays from trees growing over known mineralized ground in the Shinarump member with assays from trees growing over apparently barren ground. Other test samples were collected upslope on the Chinle

in an attempt to acquire information on the trend of the mineralized part of the Shinarump.

Botanical anomalies are tentatively defined as those areas indicated by sampled trees whose branch tips contain 1·0 p.p.m. or more uranium in the ash and thé anomalous areas are regarded as indicating mineralized ground.

In areas remote from mines and prospects where windblown uraniferous dust (contamination) is negligible, anomalous uranium contents of plants range from 1·0 p.p.m. to 5·4 p.p.m. whereas normal, contents are less than 0·6 p.p.m. These anomalous values contrast markedly with concentrations of 8·0 p.p.m. to 115·0 p.p.m. contained by plants in mine areas where there is windblown contamination. The lower values, therefore, provide a more reliable and more valid guide in prospecting at Deer Flat than the extremely high but erratic values which generally may be presumed to indicate windblown contamination.

Considerable caution must be exercised in the interpretation of botanical assay data, especially where anomalies are indicated by analyses of single isolated trees. These may be particularly misleading because of sampling and analytical errors. Riley (1956) stated that for pine and juniper samples analyses have a standard deviation equal to 0·092 *plus* 0·066 times the concentration (expressed in parts per million of uranium). The calculated standard deviation applies to uranium concentrations in the range from 0·4 p.p.m. to 40·0 p.p.m. Movement of uranium-bearing surface or ground-water from mineralized into barren localities could also cause misleading botanical anomalies. Narten (1953) stated that anomalous amounts of uranium can be absorbed by trees growing above weakly-mineralized ground ; thus it is to be expected that there will be some botanical anomalies where there are no deposits of ore grade.

The descriptive term " significant " as applied to botanical anomalies has an economic connotation denoting places thought favourable for the occurrence of uranium-ore deposits. These places have some features characteristic of ore deposits—such as, abnormally high radioactivity and special geological features, visible uranium or copper minerals, carbon, and channel-fill sandstone of the Shinarump member. Although abnormally high radioactivity and visible uranium or copper minerals are themselves guides to uranium deposits on Deer Flat, these guides could not always be discerned before they were emphasized by the broader guide of plants containing anomalously large amounts of uranium. Those botanical anomaly localities that on re-inspection have no visible ore minerals or abnormally high radioactivity at well-exposed outcrops are considered to be less significant anomalies than ones with these guides. An application of the term " significant " implies that exposures are good enough to discern geological features ; places of poor exposure have not been economically classified.

A good botanical anomaly, as distinguished from a poor one, has more tree samples with uranium contents exceeding 1·0 p.p.m. and has more consecutively or adjacently sampled trees with abnormally large uranium contents. The qualifiers " good " and " poor " relate only to anomaly reliability and do not serve to evaluate the economics of a deposit. Thus a good anomaly is not synonomous with a significant anomaly because a significant anomaly would mark a place favourable for the occurrence of an ore deposit.

Results.—Botanical anomalies, defined by plants containing 1·0 p.p.m. or more uranium, occurred above most known mineralized parts of the Shinarump member and in many other places. The anomalies not associated with known mineralized ground may indicate that the ground is underlain by uranium minerals and they suggest new areas to be tested by drilling. An attempt to wash windblown contaminating uranium from branch-tip samples proved unsuccessful and probably indicates that the dust adheres too well to plant surfaces for removal and (or) that the uranium from the dust has been absorbed through the roots or aboveground plant parts such as leaves. The authors favour the explanation that most of the contaminating uranium has been absorbed but the types of contamination could not be differentiated or evaluated. Whatever the explanation it is apparent that collections too close to mine localities will yield unreliable results for comparative purposes.

Resources of the South African Protectorates

An article in the *South African Mining and Engineering Journal* for September 9 is entitled " Some Potentialities of the Protectorates." It is stated that mining operations are being conducted in Bechuanaland at two places at present : First, the exploitation of the asbestos deposits in the Bangwaketse territory in the south-east portion of the country. Although recent operations have been affected by the setback in the asbestos market, the workings have been expanded and mechanized. Secondly, manganese is recovered in the Bamalete area, near Gaberones. Rhodesian Selection Trust has certain prospecting concessions, but apparently no discoveries of major significance have been reported so far.

The Economic Mission recently propounded the possibility of exploiting the extensive brine deposits, with a high sodium carbonate and bicarbonate in the delta of the Nata River, north of the Makarikari pan, in the north-eastern part of the territory. It has been suggested that the brine could be concentrated by solar evaporation and subsequently treated at a refining plant on the railway line. A market for salt could be developed in the Federation, which has to import all its requirements.

There are two coal seams which could be exploited. One is on the railway line south of Mahalapye and the other to the west of Palapye. Drilling has proved the existence of large reserves. The first-named is shallow which, with its position on the railway, makes it the more easily exploitable. It lies within the R.S.T. Concession area. The Mission states that the coal is of good medium South African quality, but can only be sold outside the territory if it can be raised at such cheap rates that it will be competitive after beneficiation. The seams have little dip, which makes it suitable for open-cast mining. A sustained demand for about 500,000 tons a year would be needed to justify the opening of a colliery of this type with a maximum output of 1,000,000 tons.

Coal could be competitive as far north as Francistown and possibly find a market at Mafeking and westwards, including South-West Africa. The cost of such a colliery would be £1,500,000 or more. These deposits could be used as a source of power from the Protectorate, but it is pointed out, with the shortage of water, it would be necessary to gasify the coal and burn it in gas turbines. This technique is being successfully used in dry countries throughout the world.

Basutoland so far seems to have no mineral resources of any significance. The Mission states that results of investigations into the Kimberlite occurrences have been disappointing, though this cannot be taken as conclusive.

In the technological field its greatest asset is undoubtedly the development of its water resources. Three reports on this have been compiled in the past. The first two suggest the erection of storage and power dams across the lower reaches of the Orange River in Basutoland. The third proposed diverting the flow of the upper tributaries westwards by tunnels into the steep river valleys running in a westerly direction towards the Caledon River. By means of this the steep falls available could be used for generating electric power and, when fully developed, making it possible to deliver pure water into the Orange Free State. The development of such a project could be of importance for the future of the Orange Free State and the North-Eastern Cape.

Swaziland enjoys a far greater degree of mineralization than the other two territories. The major mining activity at the present time is the great Havelock asbestos mine, with an annual output valued in excess of £2,000,000 a year.

After a long spell in the doldrums recent investigations in the Pigg's Peak area into gold occurrences have produced encouraging results. It seems likely, therefore, that the deposits—though modest in extent—will be exploited by the various concessionaires in due course.

Minor minerals existing include kaolin, barytes, and tin, but none are being worked at present. With the increasing price of tin, however, it is possible that it will attract some attention, particularly where it is associated with gold.

The big potential appears to lie in the large reserves of iron ore located in the territory. At Bomvu Ridge, which is north-east of Mbabane, the Swaziland Geological Survey estimates the existence of some 25,000,000 tons of haematite with a 64·8% Fe content. There are also other reserves which could be developed. The tentative proposal, which is dependent upon the provision of a railway, is to mine the ore by open-cast methods in the first instance and export it to overseas markets.

Coal is found in seams of mineable thickness running roughly north and south to the west of the Portuguese East border. Rand Mines have investigated an anthracite seam near Stegi, but the Mission does not think that it can be worked without the provision of a railway. At Maloma, to the south, Johannesburg Consolidated have opened up a high-quality anthracite seam, using coal cutters and an endless-belt haulage. The view is that the prospects for this mine are good, but here again transport is important, as the output at present has to be conveyed to Gollel, in North Zululand, by road.

The Mission states that the possibilities of steel manufacture must be examined. There are extensive limestone deposits in Portuguese East Africa not far from the border. Though only a small part of the Stegi coal deposits may be of coking quality, reports on the use of anthracite for smelting are encouraging. The iron ore is available and at Bomvu Ridge, at least, is of high quality.

" If the proposal is feasible," the Mission concludes, " then it will be time to decide whether Swaziland can afford to ignore it. For the time being the great value of the iron deposits to the economy of the territory is that they may justify and help pay for the establishment of a railway. It should be observed, however, that such a railway would continue after the closure of the iron mine to be a valuable capital asset only if, and to the extent that, a more diversified and less transitory type of traffic had developed in the meanwhile."

The Canadian North-West

A review by Dr. John Convey, Director of the Mines Branch, Department of Mines and Technical Surveys, Ottawa, of " Mineral Resource Development in North and West " appears in the Canadian *Engineering Journal* for September. The author says that the known mineral resources of an area that comprises about two-thirds of Canada, from the Canada–U.S. border to the Arctic and from Winnipeg to the Pacific, have at one time or another come under the scrutiny of the engineers and scientists of the Mines Branch and since a large proportion of the mineral resources of Western Canada is represented by fossil fuels the work done by the Branch on fuels is emphasized.

During the period 1930–33 a survey of the coking coals of Western Canada was carried out in a 2 ton capacity oven designed and operated by the Mines Branch. The studies during this period and subsequent investigations in two ovens of 500-lb. capacity each demonstrated the application of Canadian coals to the industry in the production of domestic coke, which was supplying an expanding market in the 1930s, and also for the manufacture of metallurgical coke suitable for use in the non-ferrous industry of Western Canada.

Most of the coking coals in Western Canada are in the medium volatile range and, in some cases, there may be dangerous expansion when the coals are carbonized in slot-type ovens. This known fact led to the development of equipment for the measurement of expansion pressures during the coking cycle, this work being instrumental to a considerable degree in the formation of a sub-committee of ASTH Committee D-5 on Coal and Coke.

In 1939 the Mines Branch co-operated in a study to demonstrate the feasibility of carbonizing coal from the Michel colliery of the Crow's Nest Pass Coal Company in Curran Knowles ovens. These ovens are a radical departure from the conventional slot-type of oven as they apply sole heating to a bed of coal. The adaption of the process to the Michel coal was advantageous in allowing more economical processing of small tonnages than in the con-

ventional slot-type oven and the mode of carbonization was suitable for an expanding coal. The results of the investigation led to the installation of a battery of 10 ovens and their success may be judged by the expansion to the present installation of 52 ovens.

With the recent interest in the development of an integrated steel industry in Western Canada requests have been made to evaluate specific seams of Western Canada for use in the manufacture of coke suitable for consumption in a high-shaft blast-furnace. Samples from the Crow's Nest, Mountain Park, and Comox areas were tested in a 500 lb. capacity movable-wall oven at Montreal. The cokes produced were evaluated for physical and chemical properties by standard methods of testing.

In view of the current market for coking coal in Japan the Mines Branch during the past year has conducted an intensive carbonization programme to demonstrate the potentialities of Western Canadian coals for the production of metallurgical coke suitable for the Japanese steel industry. The programme included the production of test-oven coke from coals and coal blends using Canadian, Japanese, and American coals. The evaluation of the samples of coke produced was made by standard methods in use in North American and Japanese steel practices.

Guaranteed ash contents of Western coking coals for export has stimulated interest in cleaning of fine sizes of coal not amenable to treatment by jigs. A 4-tons-per-hour pilot plant for cleaning of slack coals in cyclones using water only has been installed at the Western Regional Laboratory of the Mines Branch in Edmonton in co-operation with the Research Council of Alberta. A 2-tons-per-hour pilot plant for cleaning coal in heavy-medium cyclones is under construction. Furthermore, research in the dry cleaning of fines is being conducted by studying the interaction of vibratory and centrifugal forces in a pilot machine.

The Mines Branch has recognized the importance of petroleum in the Western Canadian economy for many years. The interest in the heavy oils of high sulphur content goes far beyond the tar sands of Alberta. Experience has shown that the high-quality oils are used first and that with the progress of time oils of lower and lower quality must be used. The rate at which this trend affects Canada can be gauged by detailed study of the quality of Canadian oil resources. The Mines Branch performs such a service by analysing oils and natural gases from all the significant Canadian discoveries.

As improved methods of conservation and utilization play a dominant part in the outlook of the Mines Branch much present research effort is directed to finding new methods to improve the product of Western Canadian heavy crude oils, so that these oils may be in a better position to find more stable markets in the face of keen competition.

The conversion of petroleum to refined products using high-pressure hydrogen is but one aspect of petroleum refining and facilities are under construction to provide a balanced pilot-plant laboratory for the production of a wide range of commercial products from crude oils which to-day have limited scope within the framework of the present-day refinery technology.

In petroleum technology, as in other areas, the Mines Branch has an interest in making fundamental contributions to science. It has worked out a cold-water process for the economic recovery of bitumen from the bituminous sands of Alberta. The separated bitumen is not, however, a marketable product and Fuels Division is carrying out a long-term hydrogenation programme on the desulphurization of the bitumen and of high-sulphur crude oils for the production of marketable products. In this connexion our engineers in 1955 completed the construction of a high-pressure pilot plant which will operate at pressures up to 20,000 p.s.i. They have shown that high-quality diesel oil can be produced at 10,000 p.s.i. Part of the programme is directed to the development of suitable catalysts.

The Canadian uranium industry began with the Eldorado mine at Port Radium and the Mines Branch developed the process to treat the ore. The original process developed in the early 'thirties was to recover radium from the uranium-bearing gravity concentrates and later, when uranium became important, the Mines Branch developed the more efficient acid-leaching processes to recover the uranium. The Port Radium leaching plant built in 1952 utilized the processes developed at the Mines Branch. The Mines Branch shared in the development of the high-pressure carbonate-leach process for the Eldorado Beaverlodge mine and also developed the atmospheric pressure-leach process which was later incorporated into the mill there.

To-day the main work on metallic ores concerns the concentration of low-grade iron ores. Canada has great tonnages of low-grade concentrating iron ores. These have gained much popularity with the steel industry because the use of beneficiated ores has made possible an increase of as much as 50% in blast-furnace output. Some of the iron-ore projects from Western Canada are :—

(1) Electric smelting of iron ore from Texada Island, B.C.

(2) The direct reduction of sponge iron from oolitic iron ore from Clear Hills, Alberta.

One recent project was a joint laboratory investigation by Consolidated Mining and Smelting Company of Canada and the Mines Branch to determine the feasibility of making satisfactory steel from the pig-iron which Cominco could produce from heretofore waste sulphides. After an elaborate series of experiments on manufacture and testing of steel made from varying amounts of Cominco pig-iron no significant differences could be found from standard steel.

The current development of missiles, ultra-high-speed air vehicles, and atomic-energy power plants emphasizes the need for highly-specialized alloys, possessing premium properties of high strength-to-weight ratio, high strength at elevated temperatures, and high corrosion resistance. These requirements, as well as many technological problems of the metals industries in Canada and of the Armed Forces, occupy the attention of a large staff of research scientists in the Physical Metallurgy Division.

During the last few years there has been tremendous extension of facilities to place emphasis on research for the development of new sciences and methods in order to expand Canada's position and importance in the mineral world. This new approach has required the recruiting of numerous research scientists and the obtaining of very much new and ultra-modern research equipment. While Canada is endowed with a plethora of mineral resources comparatively few of them can be regarded as in the bonanza class. There are innumerable problems of dealing with complex and often very low-grade resources which cannot be converted to marketable products without such facilities.

Mineral Exploration

In an interesting article appearing in *Optima* [1] for September B. B. Brock discusses " A Philosophy of Mineral Exploration." Dr. Brock, referring to prospecting methods still widely employed, describes the orthodox policy of mineral exploration as a working " outwards from the known mineral deposits to find similar ones in the same environment, thus extending the known boundaries of an established mineral area." Such a system, he says, was good as long as deposits occurred at reasonable depths beneath their cover of overlying rocks. " Nevertheless, with orthodox methods becoming increasingly less productive, there is now a real inducement to examine or even to institute new avenues of thought."

The new strategy involves a co-ordination of facts and experience with the object of simplifying a search for mineral patterns that can be interpreted. " When a pattern makes sense," he says, " prediction becomes possible." Dr. Brock then goes on to review " The Apparent Whimsicality of Mineral Distribution " and seeks to establish a structural framework to account for it. He seeks an order in land distribution and traces a number of axes closely related to the continental shields. In consequence he suggests that the structural pattern is itself primordial, " that order existed at least since the beginning of the geological record," a conclusion incompatible with the concept of sliding continents. Dr. Brock says that " if lateral drifting of continents were possible the result would be one of fortuity, disorder, or even chaos. Instead of that we have found order—a high degree of order." In analysing the structural framework, he goes on to say, either continents or shields might be used as a starting point, such a choice involving two different scales. Following the principle of working from the general to the particular there appears to be " a coarse crustal mosaic of a satisfying homogeneity, each unit of which can be broken down into a finer mosaic in harmony with the coarse one, and so on down the scale until arriving at a pattern which would be of use to field geologists." Between continents there is generally a mid-oceanic ridge, a submerged mountain range with only its peaks showing above water, the geometrical precision of the ridge bisecting its ocean being one of its noteworthy features. Another is that seismic lines of earthquake centres closely follow the ridges and suggest that the ridges represent " sutures " between major plates or blocks of a crustal mosaic. The seismic mosaic has one unit for each continent. The position of a continent within a seismic unit gives a clue regarding the subdivision of that unit into a finer mosaic. Observing that the oceanic frame usually has a width comparable to that of its related land mass, it is possible to reach a standard useful dimension. Subsidiary oceanic ridges, exemplified by the herringbone effect of the ramifications of the Atlantic ridge, partition off the subdivisions of the oceanic frame of Africa in sizes well matched by the three lobes of Africa: West Africa, Egypt-Arabia, and the Southern African lobe.

The unit boundaries represent the lines along which great land masses " hinge " in their individual movements. Such " hinge zones " have an elongated character of a width in keeping with the size of the unit that they bound. Although the mosaics were initially distinguished by broad considerations of size, shape, and harmony, the boundaries, where visible, are geological realities, with a set of distinguishing characteristics common to hinge zones that take up all the movement and friction and disturbance where two rigid inert masses adjust themselves to each other. Where covered by sea or superficial rocks the mosaic can be completed only by a knowledge of the pattern and its habit—that is to say, by reasoned prediction.

Since it is a disturbance between two rigid blocks that causes the phenomena of hinge zones it is reasonable to suppose, the author suggests, that the bigger the blocks the more important the disturbance. The zones separating major blocks make the greatest mountain ranges—for example, the Rockies–Andes chain, which is part of the circumpacific mountain belt.

This approach to exploration, it is concluded, is based upon structural geology in the broad sense of the term and suggests a view broad enough to avoid getting overwhelmed by structural minutiae. It involves the well-founded assumption that many, if not most, economic mineral deposits are closely related to the major fractures in the crust of the earth, having used these openings as channel ways in their ascent from the depths.

It has been observed that certain structural patterns are related to certain mineral patterns and vice versa. This is the theme of further research. The question of why certain mineral areas are where they are is far from being answered, but the approach, as outlined, supplies a fruitful manner of attack. Any research adds to the overall picture. Even if the entire answer is not forthcoming the work is not wasted, because it continues to add to the empirical background. The type of picture to emerge shows, for instance, a mineral area with its concentrations, its spatial waxings and wanings in certain directions, its sudden cutting off at a certain line (which may or may not have a tangible geological explanation). All of this can be seen in relation to the broad structural pattern. What is being built up is a closer tie-up than has hitherto existed between the structural pattern and the distribution of elements. This must be helpful in exploration, whether we know all the reasons for such distribution or not.

Obviously, the author says, in any approach to mineral exploration there can be no magical short cut to the pin-pointing of undiscovered deposits, nor in eliminating the necessity for field work, but if further research continues to clarify the structural picture it is hoped that the result will be a higher degree of selectivity of likely prospecting areas and the elimination of useless exploration in highly unlikely areas. What will ultimately result will be a series of maps showing degrees of likelihood in prospecting for certain minerals.

It is only geology that keeps exploration from being merely a lottery. With the increasing difficulty of finding mineral deposits the development of new ore-finding techniques has given rise to a false assumption that every square mile is as good as any other square mile until modern techniques have proved them otherwise. Used in combination over large areas saturation tactics become very expensive and usually the only outcome is a reasonable assurance that nothing of importance has been

[1] A quarterly review published by the Anglo American Corporation of South Africa.

overlooked. This policy minimizes the usefulness of geology; also it is not fair to geophysics and geochemistry, whose methods may appear ineffective simply because there are no mineral deposits to detect. With greater geological selectivity not only are the unfavourable odds in the exploration gamble greatly decreased on geological grounds but the geophysicist has a much better opportunity of refining his methods to suit the particular geological environment. The approach presented here, which attempts to allow of greater geological selectivity of prospecting areas, gives geophysical methods a correspondingly better chance to prove their efficacy.

This approach to exploration, Dr. Brock thinks, may well open up new fields of research in all sorts of directions which may seem unrelated or only remotely related to mineral exploration. Hitherto, unsuspected relationships between continents have been revealed. Mathematical patterns that argue strongly in favour of the relative permanence of continents go a long way towards dispelling the concept of continental drift, "which has been a major stumbling block in the path of progress in structural geology." Common habits regarding shape and size of rigid units of the crust simplify the tracing of the junctions which are economically the interesting parts of the earth. The assumption that mathematical relationships play a part in earth patterns brings the possibility of structural prediction a good deal closer.

Trade Paragraphs

Allen West and Co., Ltd., of Brighton, in a recent illustrated booklet call attention to control gear for use in machine-tool control.

D.R. Illuminations, Ltd., of Warren Street, Stockport, issue a 20-page illustrated catalogue which contains a section on industrial lighting, including non-gaseous mining and quarries, and refers to the use of festoon cable in many mines overseas.

MacCleaster Chemical Co., Ltd., (a Powell Duffryn company), of 8, Great Tower Street, London, E.C. 3, have developed a new liquid zinc anti-corrosive composition for use on iron and steel and other metal surfaces. The new preparation has a base of chlorinated rubber and zinc dust of extremely small particle size and among the advantages claimed for it is freedom from rapid settling out.

Hadfields, Ltd., of Sheffield, in a new 28-page publication describe and illustrate examples of their sectional and solid-steel jaw-breakers such as are made in sizes from 42 in. by 30 in. to 72 in. by 48 in. A cross-section view of the breaker contains a reference to its many component parts and there are useful tables of power requirements and capacities at different settings.

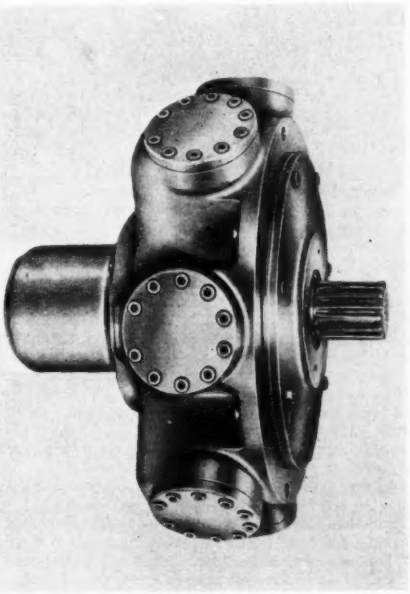
Heyes and Co., Ltd., of Wigan, announce that the North-Western Division of the N.C.B. has placed an order for an initial quantity of 500 flameproof lighting fittings for installation at the new Parkside Colliery, Newton-le-Willows, Lancs. They have already supplied two five-level Wigan Type 40 shaft signalling indicator systems which will be installed in the No. 1 shaft at Parkside.

LeTourneau-Westinghouse Co., of Peoria, Illinois, have introduced a large-capacity self-loading tractor-scraper combination in conjunction with the Hancock Manufacturing Co., of Lubbock, Texas. Built essentially for jobs where self-loading is mandatory, the Hancock elevating scraper, 10 cu. yd. Model 10E2, will load in a short time under moderately difficult conditions because of the chopping action of the slat-type elevator.

R. and J. Dick, Ltd., of Glasgow, have introduced a new type of flexible coupling called Quadriflex, having exceptional torsional flexability—15° at peak torque—and the ability to absorb vibration and shock. Simple in design it consists of two flanges and a two-piece flexible rubber sleeve. The teeth of the sleeve halves lock into the teeth of the flanges without clamps or screws and tighten under torque to provide smooth transmission of power.

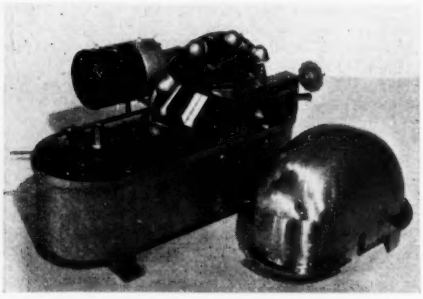
Henry Balfour and Co., Ltd., of Leven, Fife, in illustrated leaflets describe the Meader pump and pipeline system for conveying heavy slurries and material from thickeners. It is pointed out that such materials can be handled in this way under pressure over almost any route and distance and the system does not call for straight runs. The pump consists essentially of a hydraulic end and a mud end which are completely separated so that there is no contamination of the product.

Chamberlain Industries, Ltd., of Staffa Works, Argall Avenue, Leyton, London, E. 10, draw attention to their 5-cylinder and 7-cylinder radial hydraulic motors which are slow-speed high-torque power units driven by a suitable variable or constant delivery pump and may be applied to driving conveyors, haulage gear, earth-moving machinery, and in similar duties. The 7-cylinder type is shown



here. Its speed is 75–0–75 r.p.m., maximum continuous pressure 2,000 p.s.i. (peak 3,000), and torque 6,000 lb. ft. (maximum 10,000 lb. ft.)

Neldco Processes, Ltd., of Crossway House, Bracknell, Berks., draw attention to the fact that the Clarkson liquid feeder, as illustrated here, is now available in the U.K. The feeder which is used for accurate control of liquid addition in many types of processes is manufactured in stainless steel and is easily cleaned and sterilized. Control is by a hand



wheel and the amount fed can be varied from a few drops to 2 litres per minute per unit. Several units can be operated from the same gear motor and individual control is simple. For acids and highly corrosive liquids a feeder in P.V.C. is available.

NCK-Rapier, Ltd., of 32 Victoria Street, London, S.W. 1, have published a fully-illustrated 24-page booklet describing their 605 machine. This is available with front-end equipments readily interchangeable in the field so that it may be used as a 1½-cu. yd. face shovel, a 1¾-cu. yd. dragshovel, a 2-cu. yd. dragline, a 21·4-ton crane, a grab crane, or a piledriver. The standard power unit is a 125-b.h.p. diesel engine but a totally-enclosed electric motor can be fitted as an alternative. The machine is crawler mounted with separate welded frames of inverted U section and all surfaces sloped away to shed dirt. Steering is by jaw clutches and brakes, both crawlers being locked for digging.

Isaac Jackson and Sons (Fasteners), Ltd., of Glossop, Derbys., make available particulars of an ingenious and simple improvement to the conventional plate-type conveyor-belt fastener which makes for easier fitting, is eminently suitable for use with impact tools, makes a stronger more highly-compressed joint, and reduces scraper problems. The fastener is of the type which consists of flanged top and bottom plates secured by countersunk head screws and slotted hexagon or round nuts. The improvement involves turning the screw instead of the nut. High-tensile square-ended screws are engaged by a turning tool provided with an outer sleeve, having two lugs at the base which serve to hold the nut in place while the screw itself is revolved in an anti-clockwise direction.

George Cohen, Sons, and Co., Ltd., of Wood Lane, London, W. 12, in a recent announcement state that the well-known figures 600 have been registered as a trade mark. It is interesting to recall the origin of this significant number, which is by no means obscure. It is derived simply from the fact that in 1876, some 42 years after the firm's establishment, the headquarters of the company transferred to 600, Commercial Road, London, E. 14, where, incidentally, it still maintains an office block, warehouses, and a large wharf. Thereafter people within the organization began not unnaturally to talk and write about "Going to 600"; over the years the habit spread to many concerns in the metallurgical and engineering industries and in the early 1920s the figures were first used as a mark on goods and on publicity of various kinds. The figures have since become well known all over the world.

Rubber Improvement, Ltd., of Rilex House, Chandos Street, London, W. 1, have recently published a technical booklet which while dealing specifically with their Green Bond conveyor belting covers the subject of conveying generally. The company's own product is a high-tensile terylene-based thin super-flexible multi-ply belt which is now in use in mines throughout the world. It incorporates a special feature—lateral ripstops—which give improved resistance to longitudinal ripping and belt-fastener holding. Tables incorporated in the text give tension rating and recommended pulley diameters and comparative weights of 3-, 4-, 5-, 6-, and 7-ply belts in widths of 24 in., 30 in., and 36 in. against those of 32 oz. and 42 oz. cotton-duck belts. Notes on selection to suit the duty, on installation and maintenance, on procedure for making belts endless, and fault causes and remedies are included. Among illustrations are those of an installation at West Rand Consolidated Mines for *plus* 2-in. rock, 518 ft. long, driven by a 60-h.p. motor up an incline of 14° at a speed of 183 f.p.m., the load being 150 t.p.h.

Merton Engineering Co., Ltd., of Faggs Road, Feltham, Middx., state that the first of a new range of Merton four-wheel-drive loading shovels has been undergoing extensive tests for a considerable time and is now in production. Based on the successful two-wheel-drive Frontloader 59 this new model, known as the Frontloader 65A, incorporates the main design features of that machine, including front-mounted driver's position, semi-automatic hydraulic controls, 45° bucket crowd angle, and 10 ft. 8 in. clear discharge height with maximum reach of 4 ft. 10 in. The power unit of the new machine is the Fordson Major four-cylinder diesel engine which at 2,250 r.p.m. develops 61·5 b.h.p. The drive is transmitted to the four equal-size driving wheels through a single-stage 3 : 1 stall ratio hydraulic torque converter and full power-shift epicyclic gear train. Two forward and one reverse speeds are provided giving 0–4·8 m.p.h., 0–10·5 m.p.h., and 0–5·3 m.p.h. respectively. The lifting capacity at safe working load is 4,000 lb. and the maximum crowd or "pry-out" force is 10,000 lb. The standard bucket is 7 ft. 1½ in. wide to cover the full width of the machine and has a S.A.E. rated capacity of 1½ cu. yd. (or S.A.E. struck capacity of 1⅛ cu. yd.). It is strongly reinforced with doubling plates and manganese-steel wearing strips. Smaller or larger capacity buckets are also available for very heavy or lighter materials.

Michael and Partners, Ltd., of 99, Saltergate, Chesterfield, recently demonstrated to engineers of the N.C.B. a mobile elevating, screening, and stocking plant as illustrated. Known as the Loada-screen, it is manufactured by **Frederick Parker, Ltd.,** of Leicester, and by means of it materials can be stockpiled to a height of 18 ft. with negligible degradation. The apron hopper has rubber flaps at the back to seal against lorry sides and bottoms and adjustable drop fingers at the front to control the flow up the conveyor. The coal falls less than 9 in. from the conveyor head to the vibrating screen

Mobile Stocking Plant.

and a strip of belting has been fitted to slow down the material as it passes over the screen. The boom elevation, the discharge chute angle, and the rear castor wheels are hydraulically controlled from a cab which in the marketed model will be totally enclosed by sheet metal walls with perspex opening windows fore and aft.

Mounted on a pair of swivelling road wheels the machine can stockpile from one position of the hopper in an arc with a radius of 64 ft. laying down a stock 120 ft. wide.

The conveyor of the prototype demonstrated was powered by a 15-h.p. squirrel cage totally-enclosed and weatherproof electric motor and the hydraulics were operated by a 7½-h.p. electric motor. It can be powered alternatively by diesel engines. Apart from stockpiling, the Loadascreen can be used for loading road or rail vehicles. In this case a three-way discharge chute is fitted to the vibrating screen so that three grades can be loaded into three vehicles at one time. Screen cloths are supplied according to requirements.

Morgan Crucible Co., Ltd., of Battersea Church Road, London, S.W. 11, on behalf of Morgan Refractories, Ltd., issue a note on the first blast-furnace in the United Kingdom to use a British Super-duty firebrick for its complete stack lining which has just finished its initial campaign with outstanding results. This is the United Steel Companies' "Queen Bess" furnace at the works of the Appleby-Frodingham Steel Co. After operating for 49 weeks the furnace was shut down in 1958 owing to reduced iron demand, but, after reblowing in, completed an operating campaign of 131 weeks before the unit was taken off for structural repairs to the auxiliary equipment. During the campaign it produced 920,700 tons of iron involving a through-put of 2,450,000 tons of burden and 750,000 tons of coke. Throughout the entire campaign the burden consisted of 100% sinter. With the sinter containing 36% of iron, 26 cwt. of slag were produced with every ton of iron giving a total liquid output of more than 2,000,000 tons. Despite the fact that the M.R.2 bricks had to withstand on two occasions the damaging "blowing-in" process at the end of the campaign the top two-thirds of the lining was found to be in excellent condition with the lower part good enough to have supported a much longer campaign.

A more recent notice from the company states that this record has now been broken by another—for the first time a British blast-furnace operating with 100% sinter burden has produced over 1 m. tons of iron. The campaign is continuing and the stack lining is in excellent condition. As in the Queen Bess the stack is lined with M.R.2 super-duty firebricks. The campaign has now lasted 112 weeks. During this period the "Queen Victoria" has been charged with 2,570,000 tons of sinter containing 36% iron, 40,000 tons of scrap and 820,000 tons of coke; 26 cwt. of slag is tapped for each ton of metal produced, so that the liquid output of the furnace so far in this campaign is 2¼ m. tons.

W. H. Rowe and Son, Ltd., of Southampton, announce new operational systems for their pinch valves. Following industrial acceptance of hand-operated pinch valves the range has now been extended to include valves operated by lever, air cylinder, and diaphragm motor. The valve was described in the MAGAZINE for December, 1958. It is designed to handle a wide range of substances including most powders, solids in suspension, and liquids. The most important feature is that it presents a straight-through bore at all stages of valve opening. By enabling the user to fit his own actuating system the lever-operated pinch valve offers two main advantages over the manually-controlled model. It can be made to "fail safe" in the event of a breakdown in the actuating system simply by fitting a weight and it can be used as a positionally controlled valve by employing an air cylinder with a positional controller as an actuator. Mechanical linkage, flexible cables, and air or hydraulic cylinders are all suitable methods for operating.

With the exception of the air-cylinder-operated model all valves are available with bore diameter of 1 in., 2 in., and 3 in. The hand-operated valve is also available with 1½ in. and 4 in. bores. The air-cylinder-operated valve is made only in the 2 in. bore but connexion to 1-in. or 3-in. lines can be made by means of tapered adaptors. The effort required to close pinch valves varies with the

different models. With a hand-operated valve of 2 in. diameter only 8 ft.-lb. is required to close against a pressure of 100 p.s.i., while the air-cylinder-operated valve requires a pressure of 103 p.s.i. to close against a pressure in line of 100 p.s.i. compared to approximately 30 p.s.i. in the case of diaphragm-operated valves of the same bore. The 2-in. lever-operated model calls for a force of 89 lb. parallel to its vertical axis and 69 lb. at 90° to its lever arm to close against a pressure in line of 80 p.s.i.

Sleeves, reinforced for working pressures up to 100 p.s.i., are available in six standard grades. Special sleeves can also be made to suit individual requirements. Flexibility is the keynote of these sleeves. When handling raw materials which come in different shapes and sizes the sleeve can be used to break down a potential blockage; by rapidly opening and shutting the valve, any obstructive piece of raw material can be eased through.

The David Brown Companies, of Meltham, Huddersfield, recently staged an exhibition in London of a new and more extensive series of their Radicon worm-reducer units. The new range, which is manufactured in a special section of the 11-acre plant of David Brown Industries, Ltd., at Huddersfield, covers centre distances from 1⅛ in. to 8 in. and comprises two basic types—the " Adaptable " for centre distances of 1⅛ in. to 3⅜ in. and the " Solid Foot " type for centre distances of 4 in. to 8 in. These are allocated size designations of 112 to 337 for the " Adaptable " range and 400 to 800 for the " Solid Foot " type.

The " Adaptable " units cover seven sizes and give power coverage up to approximately 10 h.p. They are characterized by the fitting of detachable feet, a feature which gives versatility of application and the number of different mounting positions is almost unlimited. Compared with the previous series, the new range includes four additional sizes, while the range of ratios has also been increased to extend from 5 to 1 to 70 to 1. A special " Drywell " cover is now fitted to the slow-speed shaft and this, together with efficient oil seals on the high-speed shaft, provides efficient oil sealing in all mounting positions. So far the new range covers only single-reduction types, but designs are now being prepared to cover double-reduction units and motorized units.

The " Solid Foot " units comprise five sizes in three basic types and cover the requirements of drives up to approximately 80 h.p. They are the " U " type where the high-speed shaft is located underneath the slow-speed shaft, an ideal arrangement for the majority of applications, the " O " type, where the high-speed shaft is over the slow-speed, and the " V " type, where the high-speed shaft is horizontal and the slow-speed shaft vertical. All are interchangeable as units with corresponding " Radicon " units of the previous design but none of the individual components is interchangeable. Sizes 400, 600, and 800 are in accordance with British Standard Specification No. 3027 : 1958. The new series so far covers " U " and " O " type units only. The " V " type units are to be marketed early next year, together with a range of first-reduction helical units suitable for flange mounting to the " Solid Foot " type worm reducers and giving overall ratios of up to 280/1.

At the exhibition an interesting coloured film was shown covering all stages in the manufacture of the gear units, as well as illustrating some of the other activities of the David Brown Group.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

9,085 of 1945 (843,482). R. Q. Boyer. Electrolytic cells for reclaiming uranium from solutions.

22,745 of 1956 (842,706). J. Myard. Boring apparatus for use in mines and quarries.

30,990 of 1956 (842,621). Kennedy Van Saun Manufacturing and Engineering Corporation. Slugger roll crusher.

33,267 of 1956 (842,726). Pechiney Co. de Produits Chimiques et Metallurgiques. Production of aluminium.

2,996 of 1957 (843,014). B. D. Boitnott. Airborne gravitational geophysical exploration.

16,634 of 1957 (844,626). N. I. Ashworth. Separation of solid particles from liquids from an overflow discharge.

21,567 of 1957 (843,200). Didier-Werke A.-G. Method and apparatus for hardening briquettes.

17,321 of 1958 (842,682). International Minerals and Chemical Corporation. Potash ore treatment.

20,155 of 1958 (843,062). Blocked Iron Corporation. Lumped ore products and their preparation.

22,703 of 1958 (842,946). Sherritt Gordon Mines, Ltd. Production of copper metal powder.

29,267 of 1958 (842,302). Jersey Production Research Co. Unconsolidated formation core barrel.

32,113 of 1958 (843,581). Steinkohlenberg Werkhannover-Hannibal A.-G. Machine for driving mine galleries.

36,638 of 1958 (845,838). Union Carbide Corporation. Coagulation.

37,531 of 1958 (842,248). Horizons Inc. The metallurgy of zinc.

41,518 of 1958 (846,064). Metallgesellschaft A.-G. Sinter grate carriage.

8,255 of 1959 (844,587). American Potash and Chemical Corporation. The production of boron.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

The Interpretation of X-Ray Diffraction Photographs. By N. F. M. Henry, H. Lipson, and W. A. Wooster. Second edition. Cloth, large octavo, 282 pages, illustrated. Price 63s. London : Macmillan and Co., Ltd.

Metalli Non Ferrosi e Ferroleghe (Non-Ferrous Metals and Ferroalloys) : Statistics, 1959. Paper covers, 156 pages. Rome and Milan : Ammi s.p.a.

Tanganyika : Annual Report of the Department of Mines, 1959. Paper covers, 40 pages. Price Shs. 4/–. Dar es Salaam : Government Printer.

Kenya : Mines and Geological Department Report, 1959. Paper covers, 17 pages, with sketch map. Price Shs. 2/–. Nairobi : Government Printer.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Exports, Chile : *Iron-Ore, Chanaral.* New Facilities Accelerate Chile's Iron Ore Exports. A. T. YU, *Min. Engg.*, Aug., 1960.

Graphite, Survey : *Use, Strategic.* Strategic Graphite Survey. E. N. CAMERON, P. L. WEIS, *U.S. Geol. Surv. Bull.* 1082—E.

Production, Canada : *Lithium, Manitoba.* Manitoba Mine Yields Rare Metals. R. BRINSMEAD, *Precambrian*, Aug., 1960.

Production, Canada : *Silver, Yukon.* Canada's Leading Silver Producer (United Keno Hill Mines, Ltd.). F. H. STEPHENS, *Western Miner*, Sept., 1960.

Production, France : *Gas, Lacq.* The Natural Gas Deposit of Lacq. M. DE BEAUDEAN, *Rev. l'Ind. Min.*, Aug., 1960.

Production, United States : *Asbestos, Arizona.* Arizona Asbestos Industry is Growing Steadily around Globe. *Min. World* (San Francisco), Sept., 1960.

Production, United States : *Zinc, Tri-State.* The Bowers-Campbell Mine : Tri-State's Boot-Shaped Zinc Deposit. L. G. HAYES, *Min. Engg.*, Sept., 1960.

***Production, U.S.S.R. :** *Diamonds, Yakutia.* The Diamond Deposits of Yakutia. N. W. WILSON, THE MINING MAGAZINE, Oct., 1960.

†Resources, Canada : *Development, Review.* Mineral Resources Development in North and West. J. CONVEY, *Engg. J.*, Sept., 1960.

Resources, China : *Results, Development.* Mineral Wealth and Industrial Power : Communist China's Boasts Begin to Come True. K. P. WANG, *Min. Engg.*, Aug., 1960.

†Resources, Southern Africa: *Survey, Protectorates.* Some Potentialities of the Protectorates. *S. Afr. Min. Engg. J.*, Sept. 9, 1960.

Stockpiling, United States : *Use, Strategic.* U.S. Strategic Materials Stockpiles and National Strategy. J. D. MORGAN, *Min. Engg.*, Aug., 1960.

Geology

†Economic, Review : *Pattern, Exploration.* A Philosophy of Mineral Exploration. B. B. BROCK, *Optima*, Sept., 1960.

Economic, United States : *Mercury, Texas.* Geology and Quicksilver Deposits of the Terlingua District, Texas. R. G. YATES, G. A. THOMPSON, *U.S. Geol. Surv. Prof. Paper* 312.

***Economic, U.S.S.R. :** *Diamonds, Siberia.* The Diamond Deposits of Yakutia. N. W. WILSON, THE MINING MAGAZINE, Oct., 1960.

Oil, Canada : *Exploration, Yukon.* Oil and Gas Exploration—Eagle Plains Area, Yukon Territory. W. G. CAMPBELL, *Canad. Min. Metall. Bull.*, Aug., 1960.

Regional, United States : *Souris River, Dakota.* Geology of the Souris River Area, North Dakota. R. W. LENKE, *U.S. Geol. Surv. Prof. Paper* 325.

†Survey, Geobotanical : *Uranium, United States.* Botanical Prospecting for Uranium in the Deer Flat Area, Utah. A. J. FROELICH, F. J. KLEINHAMPL, *U.S. Geol. Surv. Bull.* 1085—B.

Survey, Geochemistry : *Uranium, United States.* Chemical Composition as a Guide to the Size of Sandstone-Type Uranium Deposits in the Morrison Formation on the Colorado Plateau. A. T. MIESCH and others, *U.S. Geol. Surv. Bull.* 1112—B.

Survey, Geophysics : *Gravity, Canada.* New Method of Elevation Control Speeds Reconnaissance Gravity Survey in Northern Areas. N. R. PATERSON, *Canad. Min. Metall. Bull.*, Aug., 1960.

Metallurgy

Analysis, Mineral : *Powder, Spectrochemical.* Method for the Quantitative Spectrochemical Analysis of Rocks, Minerals, Ores, and Other Materials by a Powder D-C Arc Technique. H. BASTRON and others, *U.S. Geol. Surv. Bull.* 1084—G.

Hydrometallurgy, Uranium : *Progress, France.* Recent Developments in the Chemical Treatment of Uranium Ores in France. R. BODU, *Rev. l'Ind. Min.*, Aug., 1960.

Sintering, Iron-Ore : *Automation, Review.* Development of Sinter-Plant Automation : Outline of General Principles. *Iron, Coal Tr. Rev.*, Oct. 7, 1960.

Smelting, Blast-Furnace : *Fuels, Solid.* Injecting Solid Fuels into Smelting Zone of an Experimental Blast Furnace. E. J. OSTROWSKI and others, *Rep. Inv. U.S. Bur. Min.* 5648.

Steel, Bessemer : *Oxygen, Use.* Bottom-Blown Oxygen for Desiliconization of Iron. *Iron, Coal Tr. Rev.*, Sept. 16, 1960.

***Steel, Progress :** *Use, Oxygen.* Oxygen in Steelmaking. W. H. DENNIS, THE MINING MAGAZINE, Oct., 1960.

Machines, Materials

Beryllium, Survey : *Outlook, United States.* Beryllium To-day and To-morrow. *Engg. Min. J.*, Sept., 1960.

Computors, Digital : *Use, Control.* The Digital Computor: Applications in Mining and Process Control. P. B. NALLE, L. W. WEEKS, *Min. Engg.*, Sept., 1960.

Excavators, Bucket-Wheel : *Use, Germany.* Bucket-Wheels in Germany. *Min. Engg.*, Sept., 1960.

***Quartz, Sintered :** *Use, Missiles.* Quartz for I.C.B.M. A. E. WILLIAMS, THE MINING MAGAZINE, Oct., 1960.

Timber, France : *Use, Underground.* The Use of Timber for Underground Support. *Rev. l'Ind. Min.*, No. Spec., July 15, 1960.

Mining

Bolting, Roof : *Tests, Anchorage.* Evaluating Anchorage Testing Methods for Expansion-Type Mine Roof Bolts. A. J. BARRY, J. A. MCCORMICK, *Rep. Inv. U.S. Bur. Min.* 5649.

Breaking, Piercing : *Jets, Flame.* Jet Piercing for Hard Rock Formations. L. WALTER, *Mine, Quarry Engg.*, Oct., 1960.

Data, Correlation : *Processing, Machine.* Data Processing by Machine: Asset at the Mine Site. G. S. KOCH, R. F. LINK, *Min. Engg.*, Sept., 1960.

Excavation, Underground : *Openings, Design.* Design of Underground Openings in Competent Rock. L. OBOOT, W. I. DUVALL, R. H. MERRILL, *Bull. 587 U.S. Bur. Min.*

General, Germany : *Lead-Zinc, Harz.* The Rammelsberg Mine. H. EICHMEYER, *Mine, Quarry Engg.*, Oct., 1960.

General, Sand : *Plant, United Kingdom.* Sand Production at Warmwell. *Mine, Quarry Engg.*, Oct., 1960.

Grouting, Cement : *Progress, Review.* Cement Grouting. L. A. YORK, *Precambrian*, Aug., 1960.

Handling, Transport : *Coal, United Kingdom.* Coal Clearance: A Review of Underground Transport. H. H. WILSON, *Trans. Instn. Min. Eng.*, Sept., 1960.

Hazard, Methane : *Drainage, United Kingdom.* Methane Drainage in the Barnsley Seam of South Yorkshire. E. WHITE, H. WRIGHT, *Trans. Instn. Min. Eng.*, Sept., 1960.

Hazards, Fire : *Control, Foam.* Controlling Fires in Mines with High-Expansion Foam. J. NAGY and others, *Min. Engg.*, Sept., 1960.

Hygiene, Ventilation : *Principles, Practice.* Introduction to Mine Ventilating Principles and Practices. D. S. KINGERY, *Bull. 589 U.S. Bur. Min.*

Opencast, Caving : *Gold, Philippines.* Block Caving Used for Low-Cost Mining of Highly-Fractured Copper-Gold Ore-body in the Philippines. G. A. SCHOLEY, *Min. World* (San Francisco), Sept., 1960.

***Opencast, Germany :** *Use, Excavators.* Giant Excavators in Opencast Work. R. J. SALTER, THE MINING MAGAZINE, Oct., 1960.

Research, South Africa : *Industry, Gold.* Research in the South African Gold-Mining Industry. W. S. FINDLAY, *J. S. Afr. Inst. Min. Metall.*, Aug., 1960.

Safety, Hoisting : *Arresters, Cage.* Aluminium-Honeycomb Cage Arresters. G. K. GREENHOUGH, *Coll. Engg.*, Sept., 1960.

Sinking, Shaft : *Copper, Morocco.* Fast Shaft Sinking by Conventional Methods at El Akeba, Morocco. K. HARTLAND, *Engg. Min. J.*, Sept., 1960.

Support, Coal-Face : *Props, Walking.* Trials Carried out with Forward-Moving Propping Systems in France. M. R. CŒUILLET, *Ann. Mines*, Sept., 1960.

Support, Ground : *Load, Assessment.* Support Loads at the Coal Face. J. D. JENKINS, I. STOREY, *Trans. Instn. Min. Eng.*, Sept., 1960.

Support, Ground : *Timber, France.* The Use of Timber for Underground Support. *Rev. l'Ind. Min.*, No. Spec., July 15, 1960.

Support, Roof : *Loads, Assessment.* The Use of Pack Dynamometers. N. J. PRICE, N. MAY, *Coll. Engg.*, Sept., 1960.

Ore-Dressing

***Diamonds, South Africa :** *Blue Ground Treatment.* Treatment of Blue Ground. Ore-Dressing Notes, THE MINING MAGAZINE, Oct., 1960.

Flotation, Research : *Scatter, Results.* On the Scatter of Flotation Test Results Obtained in the Laboratory. P. RAFFINOT, *Rev. l'Ind. Min.*, Aug., 1960.

General, United States : *Gold, Montana.* Arsenic Problem of Marietta Gold Ore Finally Solved by Selective Flotation. W. R. WADE, *Min. World* (San Francisco), Sept., 1960.

Gravity, Sink-Float : *Iron, United States.* Mesabi Scrubber Helps Heavy-Media Performance. W. R. VAN SLYKE, R. C. FERGUSON, *Engg. Min. J.*, Sept., 1960.

Gravity, Sink-Float : *Washer, Cyclone.* The Dutch State Mines Dense-Medium Cyclone Washer. C. KRIJGSMAN, *Coll. Engg.*, Sept., 1960.

Salt, United States : *Separation, Dry.* (1) Development of a Thermoadhesive Method for Dry Separation of Minerals. R. J. BRISON, O. F. TANGEL; (2) Beneficiation of Rock Salt at the Detroit Mine. W. C. BLEIMEISTER, R. J. BRISON, *Min. Engg.*, Aug., 1960.

Separation, Magnetic : *Machine, Forrer.* The Forrer Separator: A New Apparatus for the Wet-Sorting of Slightly Paramagnetic Substances. J. DE ROBERT, L. CASNABET, *Rev. l'Ind. Min.*, Aug., 1960.

Thickeners, Control : *Magnetite, Canada.* Automatic Thickener Control at Marmora Mine. W. M. AUBREY, *Min. Engg.*, Sept., 1960.

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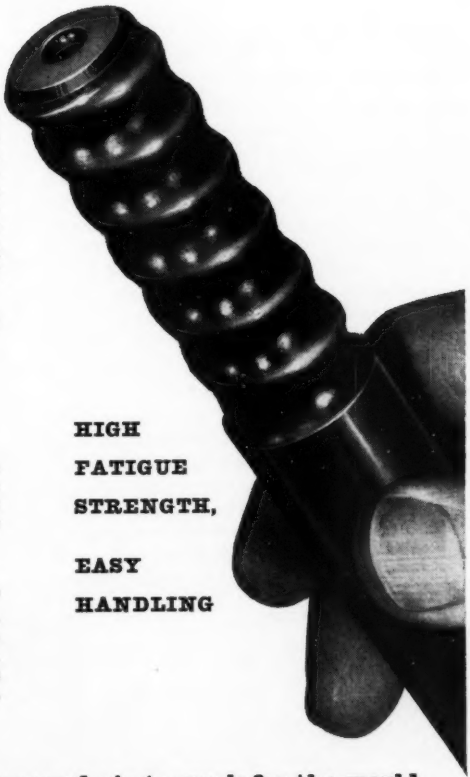

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COMPANY MEETINGS AND REPORTS SECTION

WESTERN MINING CORPORATION

The annual general meeting of Western Mining Corporation Limited, was held on September 7 in Melbourne.

Mr. G. Lindesay Clark, B.Sc., M.M.E. (the chairman) presided and paid tribute to the memory of the late Sir Samuel Burston, a director of the company, who died suddenly on August 21.

(All figures quoted are in Australian currency.)

Net profit £255,380 for the year ended March 31, 1960, was £53,000 less than last year due to some £57,000 interest receivable from Great Western Consolidated N.L. not having been brought to account.

The Corporation has provided assistance to Great Western Consolidated for a number of years past in the expectation that vigorous exploration would turn up extensions and repetitions of known ore bodies in the Yilgarn district. The results of the exploration over the last 12 months have been particularly disappointing. During 1960 the Corporation has had to provide an additional £50,000 and the Government of Western Australia has provided a similar amount. This was done to maintain the scale of operations so as to ensure that a maximum financial realization will be obtained from mining the remaining ore reserves. There remains only a slender chance that the limited exploration now being done might find a new ore body. Failing this the company has no option but to continue to work the available reserves and then proceed with the realization of plant. In these circumstances Western Mining Corporation will incur a substantial loss in respect of its loan and share investments in Great Western Consolidated.

Dividends have continued at the rate of 1s. per year and have absorbed £189,435.

Summarizing our gold business, developments are continuing satisfactorily at Central Norseman and Gold Mines of Kalgoorlie. We have had a very severe setback at Great Western which has made serious inroads into our resources.

In commenting on prospecting for minerals other than gold the chairman said :

Aluminium

Western Aluminium No Liability, in which this company has the principal interest, has continued its exploratory work on bauxite deposits in the Darling Ranges of Western Australia. The Progress Report issued in July of this year advised that exploratory drilling from October, 1958, to April 26, 1960, had indicated reserves of 37,000,000 tons of bauxite containing 44% Al_2O_3 and that these reserves included 13 million tons containing 47% Al_2O_3. Testing so far has covered only a minor part of the area known to contain bauxite ; and current drilling continues to add to the reserves. It is already clear that we have established the existence of a major bauxite deposit. The situation of the deposits in a settled district close to the coast and established ports adds greatly to their potential value. Following satisfactory tests on small scale parcels at their works in Japan, three 10,000 tons trial shipment have been despatched to Japanese smelters.

Coal

Drilling for opencut coal as a basis for power supply is continuing in the Collie-Wilga district, Western Australia.

Copper

No further work has been done on the Tarraji property in 1960 and it is proposed to abandon our mining titles to the area.

Talc

During the year the company acquired a half interest in the Three Springs Talc Mine which is located near the Perth Geraldaton railway line about 190 miles north of Perth. Talc is a non-metallic mineral widely used in industry in steadily increasing amounts as an inert filler and having its major uses in the cosmetic, ceramic, paint, paper, rubber and insecticide industries. Already high grade talc reserves exceeding 1,000,000 tons and a much larger quantity of lower grade talc have been proved.

The report and accounts were adopted.

KALGOORLIE SOUTHERN GOLD MINES NO LIABILITY

The annual general meeting of Kalgoorlie Southern Gold Mines No Liability was held on September 5 in Melbourne.

Mr. G. Lindesay Clark, B.Sc., M.M.E. (the chairman) presided and paid tribute to the memory of the late Sir Samuel Burston, a director of the company, who died suddenly on August 21.

(All figures quoted are in Australian currency).

Development expenditure for the year amounted to £23,281. Expenditure on plant and machinery amounted to £13,700 most of which represents the cost of the new deep drill. Net current assets at March 31, 1960, were £11,191 most of which has been absorbed by our operations since that date. To finance work in the immediate future a call of sixpence per share was made payable on August 10, 1960.

After commenting on the abandonment of Hole S.E. 11 due to caving ground at 1,528 feet, the chairman continued :—

A new Hole S.E. 12 was started near S.E. 7 at 85 degrees. The hole had reached 4,310 feet on August 24 and is now flattening.

This will delay entry of the hole into the zone of interest but if our geological interpretation of the Cavalier structure is correct the hole should enter this zone in about another 1,500 feet. Hole S.E. 7 in this zone at a higher level and in the western limb of the syncline only, intersected a number of mineralized veins, some of which carried gold. On account of the limited range of the drill only the West side of the Cavalier Syncline could be tested in S.E. 7. The target for the new hole includes both the East and West limbs of the syncline at a depth some 1,000 feet below the intersection made in S.E. 7.

The new drill is operating satisfactorily and at the present depth is making an advance of about 170 feet per week.

The report and accounts were adopted.

GEEVOR TIN MINES, LIMITED.

The forty-seventh annual general meeting of Geevor Tin Mines, Ltd., was held on September 14 in London.

Mr. G. W. Simms (the chairman) presided and the following is an extract from his statement for the year ended March 31, 1960 :—

The profit (before taxation) amounted to £58,463. After providing £27,542 to meet taxation, your directors recommend the payment of a final dividend of 2s. per share, making, with the interim dividend of 6d., a total distribution for the year of 2s. 6d. per share, less tax, requiring £31,605.

Generally speaking, development results throughout the year have been disappointing. Our difficulties have been further increased by the fact that recent investigation has shown that the sea has entered the undersea workings of the old Levant mine. As we have development rights over the undersea leases, which adjoin our leases on the west, and as the ore chutes in our lodes pitch to the west, this has the effect of severely restricting development possibilities in that direction. If, therefore, we are to maintain our ore reserves position it is necessary to intensify efforts to try to discover other payable lodes within reach of our present workings. With this object in view diamond-drilling operations were started and are being continued during the current year, though the purpose of the first holes drilled was to test the extension of some of our known lodes.

As compared with the previous year, operating costs at the mine were lower by 1s. per ton of ore milled. In part this is due to the lower development footage. It is, however, some satisfaction to know that even a small reduction has been effected and that it would have been substantially greater but for increases in wages and in the cost of electric power. But the saving we were able to effect was offset by the increase of 100% in our rates, brought about by the action of Government in connexion with the de-rating of industry to which I referred in my address last year.

As the years pass and nothing is done by Government to alleviate the incidence of mine taxation in this country, one cannot help but wonder if it has even considered the question of the development of the Cornish tin-mining industry from the standpoint of enlightened self interest. Having regard to the position in Bolivia, Indonesia, and now the Congo, three countries of great importance as regards tin production, it seems a reasonable expectation that world supplies of tin are likely to be adversely affected in future. If that be so, surely the time has come to encourage the development of the tin-mining industry in this country. Long-term measures are required and the first of these is alleviation of taxation by way of adequate depletion allowances for a wasting asset and recognition of the high-risk nature of mining enterprise by granting taxation relief in the early operating stages.

The report and accounts were adopted.

GOLD MINES OF KALGOORLIE (AUST.)

The annual general meeting of Gold Mines of Kalgoorlie (Aust.) Limited, was held on September 6 in Melbourne. Mr G. Lindesay Clark, B.Sc., M.M.E. (the chairman), presided.

(All figures quoted are in Australian currency).

Net profit for the year ended March 31, 1960, was £323,869 compared with £248,686 for 1958–59, an increase of £75,183. This year's profit included £204,920 Gold Subsidy, £108,712 less than last year. The substantial drop in gold subsidy reflects the improvement in the Company's operations.

A dividend of 1s. per share absorbing £202,265 was paid on December 3, 1959. This was an increase of 1½d. on the previous year's dividend of 10½d.

The mill averaged 40,343 tons per four weekly period and treated a total of 524,461 tons for the year. The average tonnage per four weeks was nearly 1,000 tons higher than last year. Gold recovered amounted to 142,072 fine ounces, being 131,517 ex Mill, 10,497 from concentrates treated at Fremantle and 58 from clean-up of the K.O.T. mill. Gold in concentrates awaiting treatment at Fremantle increased by 3,145 ounces. The head grade from the mines averaged 6·06 dwts. per ton and the residues 0·52 dwts. giving an overall recovery of 91·4%.

The average costs of mining and treatment of ore from Kalgoorlie and Coolgardie were 2·2s. per ton lower than last year. In addition, mining costs decreased 1·1s. to 51·2s. per ton, treatment costs decreased by 0·6s. per ton and development redemption increased by a similar amount.

Ore reserves at March 31, 1960, were estimated at 1,287,000 tons averaging 5·8 dwt. per ton. This represents a slight increase in tonnage over last year and 0·1 dwt. higher grade.

Kalgoorlie Development. During the year 34,485 feet of development was done of which 1,167 was special work in connection with service, haulage connections and ore passes. Of the 33,318 feet of normal development, 22% was in ore averaging 10·1 dwt. over 66 inches. Since the end of the year, to August 16, 1960, 13,290 feet of normal development has been done of which 20% was in ore averaging 9·9 dwt. over 65 inches.

At Bayleys Mine, Coolgardie, further extensions of the South Shaft and Consols reef were found. An internal shaft is being sunk from No. 11 Level to open Prices and New Prices reefs at lower horizons where some spectacular values have been obtained. Since the end of the year driving at No. 12 level has exposed a continuous length of 86 feet of ore on New Prices reef averaging 26·5 dwt. over 46 inches.

The report and accounts were adopted.

KENTAN GOLD AREAS, LIMITED

Mr. Michael Easby's Review

The Annual General Meeting of Kentan Gold Areas Limited was held on September 29 at the Chartered Insurance Institute, London, E.C. Mr. Michael Easby, F.C.A., managing director, presided.

Mr. Easby referred to the grievous loss which the company had suffered through the deaths of the chairman, Mr. Christopher Holland-Martin, and of Mr. G. F. Webster, and announced that Mr. E. F. O. Gascoigne had accepted the board's invitation to assume the chairmanship as from September 30, 1960

In his printed review Mr. Easby had reiterated that the group's principal asset was now its holding in Tanganyika Concessions, Limited, which was vitally interested in the the well-being of the mineral industry of Kantanga and he now emphasized that the prosperity of the group continued to depend on a satisfactory solution of the problems of the Congo, as to the outcome of which it was at present impossible to hazard any forecast. In the meantime the uncertainties of the situation had been substantially discounted in the current market price of the company's shares.

The consolidated accounts at March 31, 1960, reflected the first full year's working since acquisition of the entire share capital of the Zambesia Exploring Company, Limited. The unappropriated profits of the subsidiaries had been transferred to the parent company by way of dividend and the capital reserve arising from these unappropriated profits, amounting to £548,564, had been reclassified as a revenue reserve. The equity investment in Geita Gold Mining Company, Limited, had been written down to a value of ¼d. per share. The profit for the year was £166,816 and after bringing forward the previous year's balance and allowing for the reclassification of reserves and the adjustment of taxation of past years, a balance of £761,807 remained available for distribution. An interim dividend of 1s. 6d. per share (7½%) had been paid on March 11, 1960, and it was proposed to recommend a final dividend of 2s. per share (10%), making a total dividend for the year of 3s. 6d. (17½%), which was the same as for the previous year.

Detailed information was given in the printed review regarding the company's principle interests, including Tanganyika Concessions, Limited, Tanganyika Holdings Limited, in which a participation of 50% was held, and the subsidiary company, Geita Gold Mining Company, Limited. With regard to the last named, Mr. Easby reported that the last of the four boreholes comprising the surface diamond drilling programme had been completed at a depth of 1,868 ft., having intersected two ore zones at depths of 1,586 ft. and 1,726 ft. giving average values of 4·6 dwt. and 4·5 dwt. per ton over true widths of 22 ft. and 8 ft. respectively. While satisfactory in indicating the continuance of mineable ore-bodies in the mine's north-east extension, these results confirmed the board's view that the mine's future must be planned as essentially that of a low-grade proposition.

The report and accounts were adopted.

KINTA KELLAS TIN DREDGING CO., LIMITED

A More Satisfactory Year

The 33rd annual general meeting of Kinta Kellas Tin Dredging Co., Ltd., was held on September 29 in London, Mr. T. H. Macer, M.C. (the chairman) presiding.

The following is an extract from his circulated statement :

I am very pleased to be able to report that 1959–60 was a much more satisfactory year for the Company, the gradual easing of the very severe restriction of output and the slightly higher prices obtained for our ore have resulted in a profit, after providing for taxation, of £20,852 as against only £1,628 for the previous year.

During 1960–61 we have to replace our chain of digging buckets at a cost of £35,000 and, in view of the company's present rather restricted liquid position, your directors have considered it only prudent that a considerable proportion of the above profit should be retained in the company.

The dredge was closed down for only 65 days during the year compared with 218 days in 1958–59. The output was 276·60 tons of tin ore, permissible sales under the Tin Export Control, including quotas received from the Common Surrender Pool and the Osborne and Chappel Grouping Scheme, amounted to 223·83 tons, leaving a stock of tin ore surplus to quota of 95·90 tons, which is approximately the maximum amount the company is permitted to hold. At the present time production of tin in Malaya is considerably below the amount which that country is permitted to export under the International Tin Agreement and the question of the orderly disposal of stocks of tin surplus to quota held on mines is receiving active consideration by the Malayan Government. I am hopeful that during the latter half of the present year we shall be permitted to dispose of our surplus stock. Then, providing the price of tin remains at around the present level, and I cannot foresee any reason for it not doing so, the decision to operate the dredge in 1959–60 so as to produce the maximum amount of permissible stocks of ore will have been amply justified.

I referred in my last statement to the fact that the company would qualify on July 1, 1960, for a revision of its assessment. I am happy to advise that our assessment has been increased from 290 tons per annum to 344 tons per annum as from that date. The present rate of quota is approximately 95% of the new assessment and, helped by allotments of quota from the Common Surrender Pool, I am hopeful that there will be no necessity for the dredge to be shut down in 1960–61 through restriction.

Commenting on the future, the chairman said : At present there are indications that 1960–61 will be a year of satisfactory profits for the company but, with conditions almost back to normal, consideration now has to be given to capital works which had to be postponed during the period of restriction of output.

The report and accounts were adopted.

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22nd September, 1960.

By Order,
G. H. WARD,
L. J. LITTLE,
Joint London Secretaries.

FEDERAL GOVERNMENT OF NIGERIA

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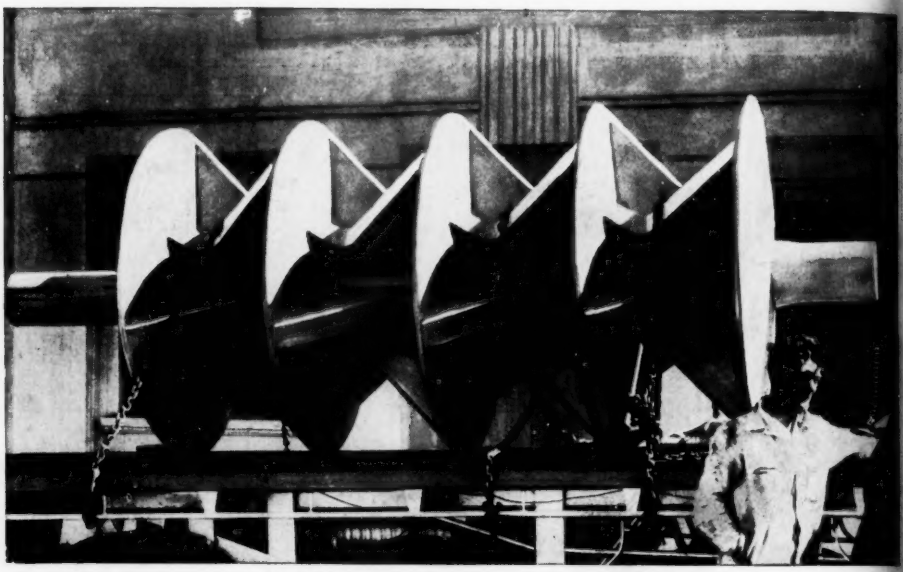

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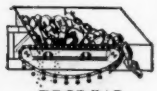

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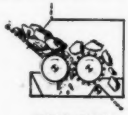

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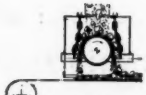

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